MECHANICAL ENGINEERING

September 1957

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ASME Annual Meeting • New York, N.Y. • December 1-6, 1957

DUNLOP CUTS STEAM COST 23½% PER TIRE

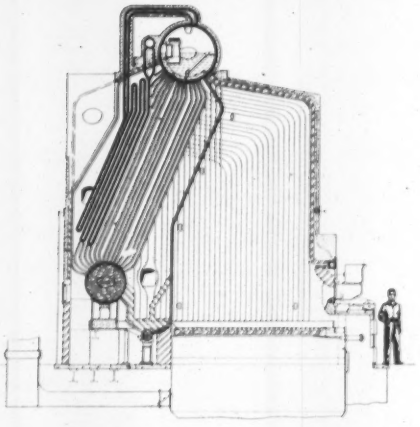
New B&W FP Boilers Burn Less Coal ... Supply Higher Temperature Steam

At Dunlop Tire & Rubber Company's Buffalo Plant, these big, modern curing presses are stepping up tire production. But they need plenty of dependable steam at fairly high temperature. The boilers they had couldn't do the job so they installed two new B&W Integral-Furnace Boilers.

These new boilers not only supply that "increased production" steam, but burn less coal and generate more steam than the old boilers, using the same limited space—a combination that cuts steam cost per tire 23½%.

Dunlop installed its first six B&W units in 1920, when the Buffalo Plant was new. Although still capable of reliable service after 37 years, the higher steam temperature demand of modern tire making has marked the four remaining old boilers for early replacement by more efficient B&W FPs.

Dunlop's experience with B&W boilers is typical of thousands of industrial, utility, commercial and institutional users. So if you use steam for power, processing or heating ... if you want to modernize or expand your plant ... if you have a steam plant problem of space or fuel or fly ash ... call B&W and get the benefit of 90 years of steam experience. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.



Each B&W FP unit can supply 40,000 lb of steam per hr at a pressure of 260 psi and temperature of 505 F. New boilers were specially designed to fit space used by old units they replaced. Zack C. Hinds, Buffalo, New York, was the Consulting Engineer on the project.

G-801-1B

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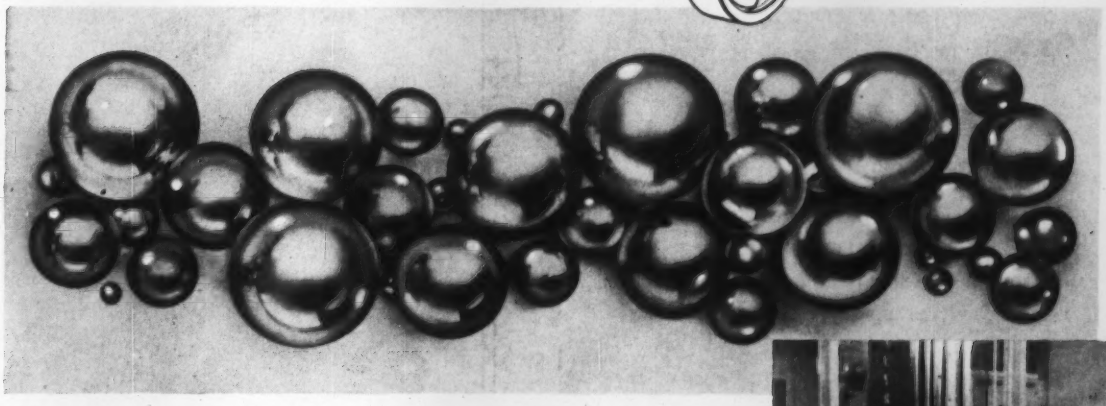
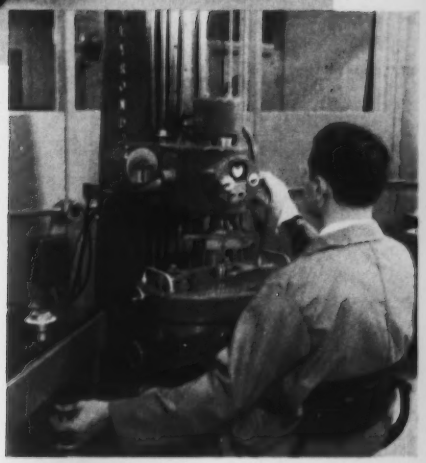
BOILER DIVISION

FACTS

about

NEW DEPARTURE STEEL BALLS





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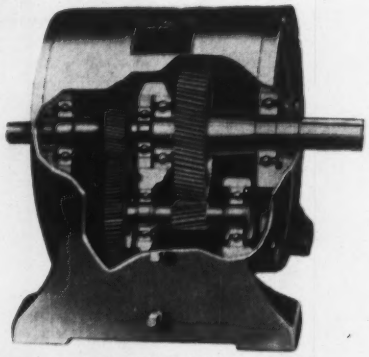
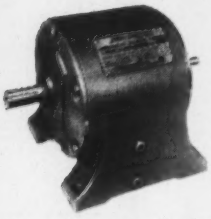


Cutaway View Double Reduction Type RD



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Leo Garland and James Game, plant superintendent of Globe Fuel Products, stand by as Charles Knonson installs the valve on the steam line for test.

"When we get into a tough valve situation," says James Game, plant superintendent of Globe Fuel Products, Inc. at Chicago, "we appreciate the personal interest that Walworth people show in our business."

Mr. Game had a particular case in mind. Globe Fuel Products operates a fuel oil tank farm. Burning oils, in barges, are received at the dock. In order to reduce the oil viscosity to facilitate pumping, steam is piped, through flexible hose, to coils in the barges. Globe Fuel has standardized on Walworth 726F Iron body Wedge Gate valves as general-purpose valves handling burning oils as well as steam.

Mr. Game urgently needed a valve for this service, and contacted his local Walworth sales representative, Leo Garland, who arranged to have the needed valve delivered to the job by private automobile.

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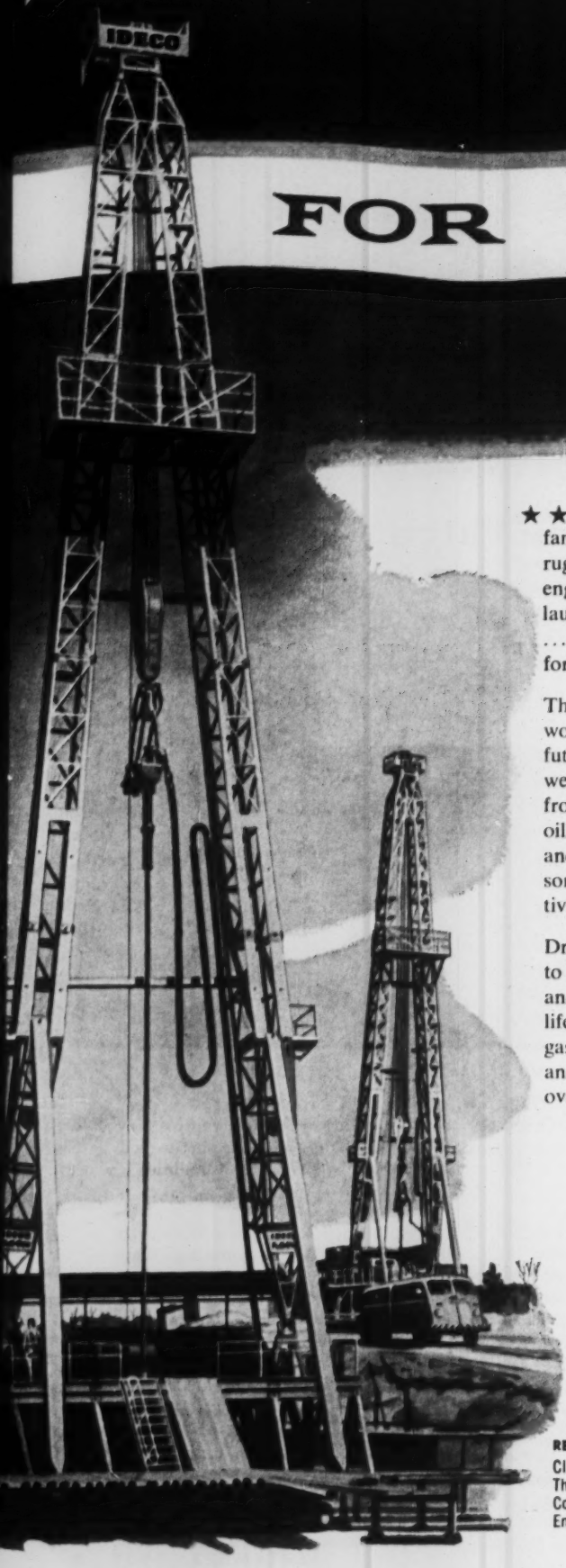

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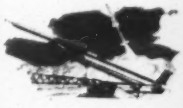

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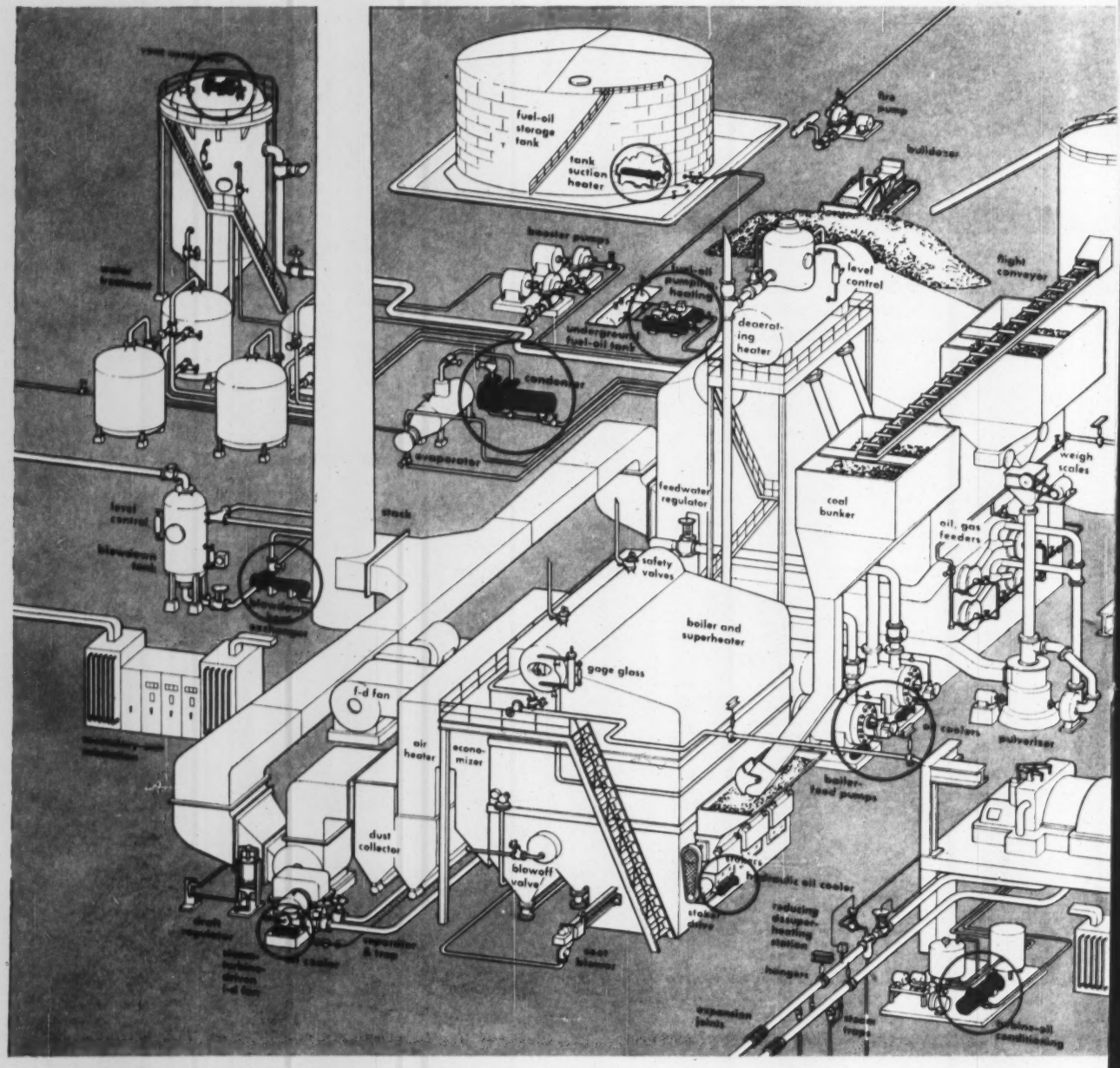

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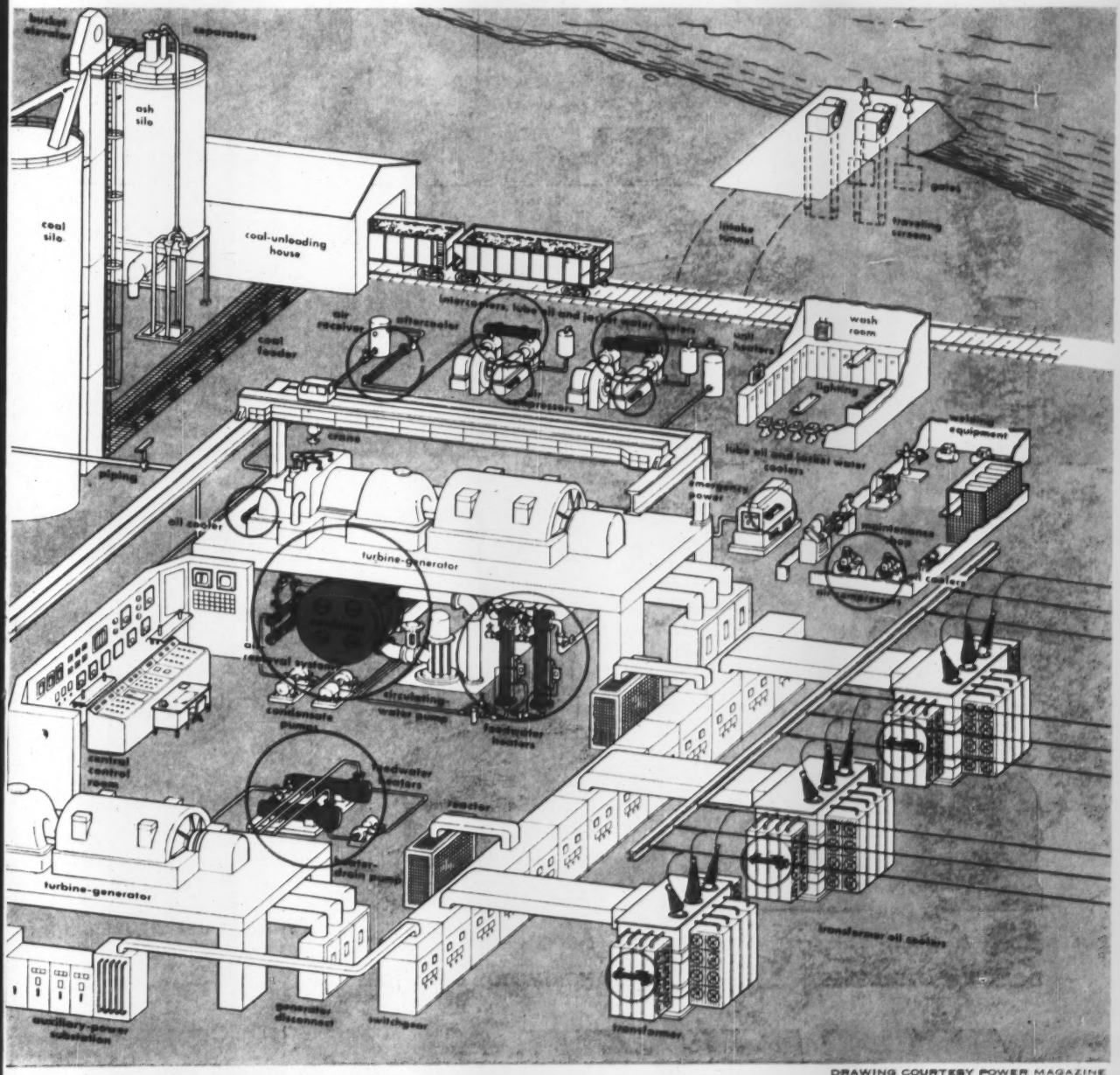

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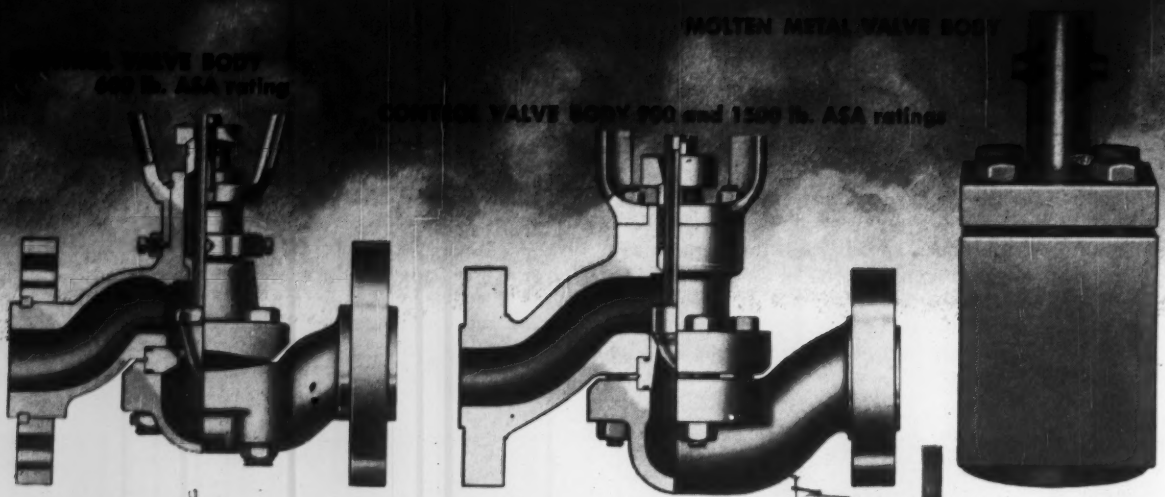

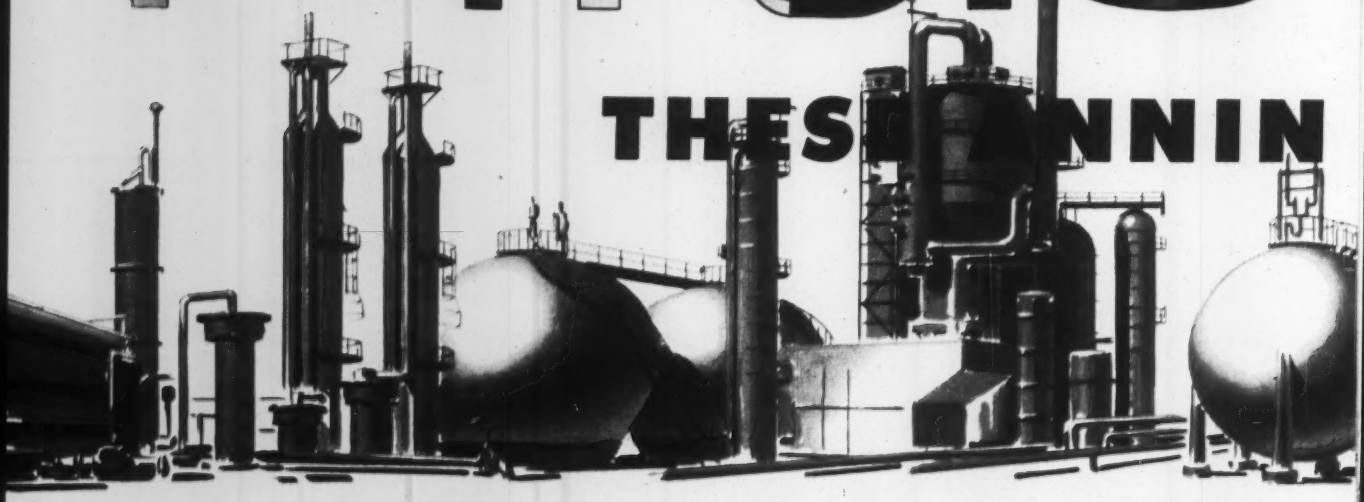

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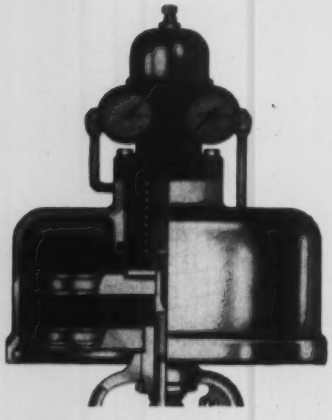

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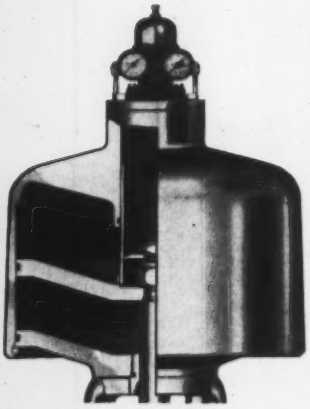

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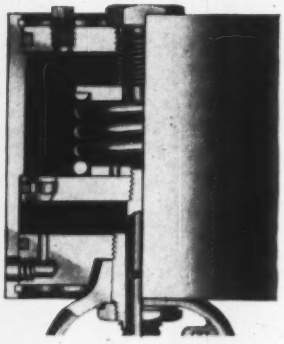

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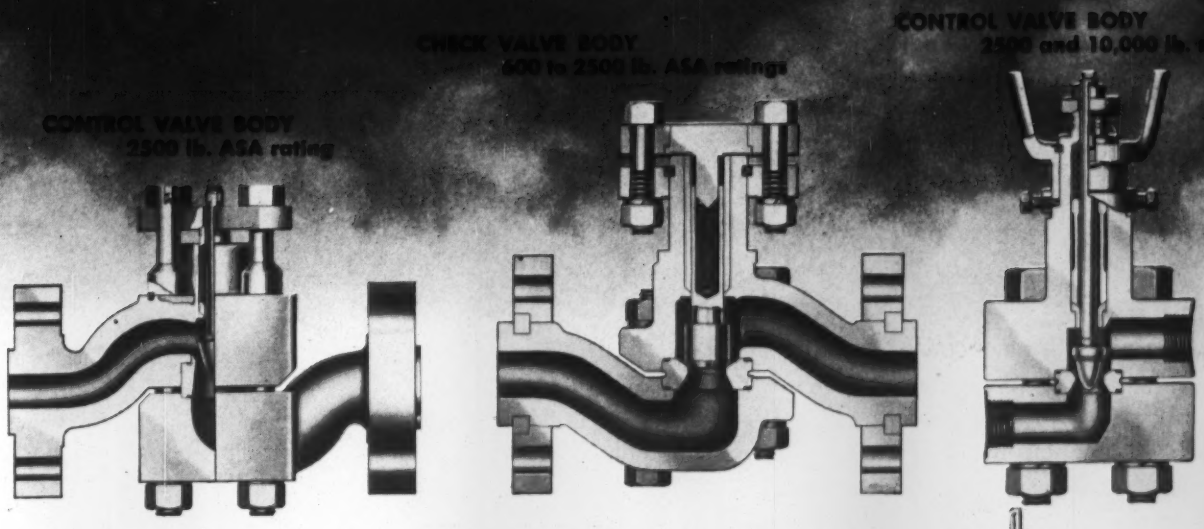
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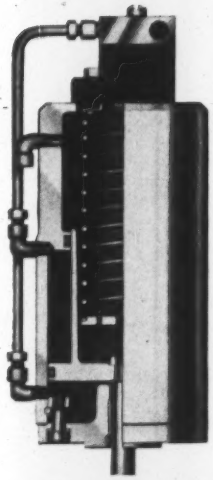

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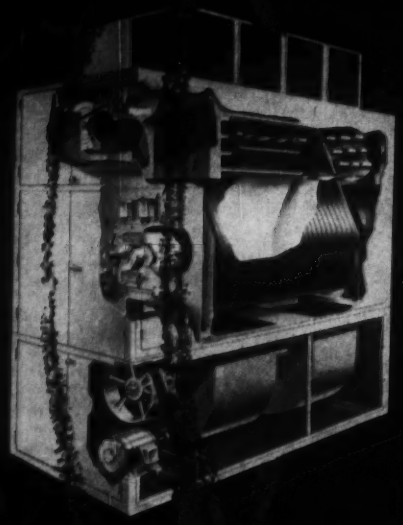
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Dravo presents: the first dual-fuel burner designed specifically for direct-fired heaters

PYROJET *burner tops list of features in all-new Dravo Counterflo heater*

Intensive research by Dravo engineers has resulted in the development of the first dual-fuel burner specifically designed for use in a direct-fired space heater. This burner, the PYROJET, burns light oil, heavy No. 5 oil, or gas with equal efficiency. The combination gas/light oil models feature automatic switchover with *no manual adjustment*. Here are some of the outstanding features of the Dravo PYROJET burner.

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- Automatic switchover on light oil/gas combination models . . . no manual adjustment
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A Multipress case study

How to automate production

Multipress curbs costs of Dormeyer mixer parts . . . triples output by integrating three separate operations

Often, a series of operations can be combined to both improve product quality and cut production costs. This was the experience of Haber Corp. when they streamlined production of beater spindles for their Dormeyer automatic food mixers.

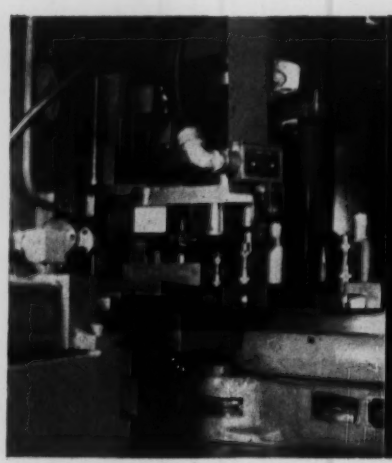
By reducing the size variations of slots cut into the spindles and thus eliminating the need for deburring, quality was boosted . . . costs cut.

A special 8-ton hydraulic Multipress was selected to combine three machining operations. Only loading parts on the 12-station hydraulic index table is performed manually. Once the cycle-start button is pressed, the parts advance step-by-step until a small flange-mounted cylinder ejects the finished beater spindles.

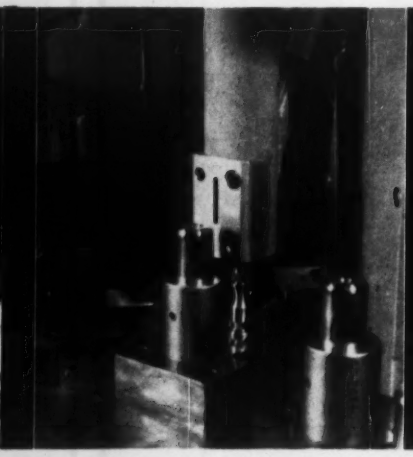
In separate manual operations, production rates of from 200 per hour for cutting slots to 450 per hour for deburring had been standard. With Multipress, a continuous flow of 1020 beater spindles per hour is achieved with only one operator.

Advance cost analysis estimated that equipment and tooling would be amortized within a year due to increased production and quality. Actual production proved this estimate too conservative.

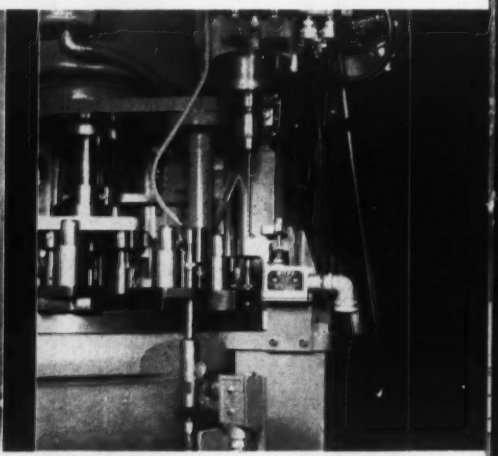
Find out how Denison hydraulic Multipress can perform a three-in-one job for your company—improving quality, speeding production and cutting costs. Write to Denison Engineering Division, American Brake Shoe Co., 1174 Dublin Road, Columbus 16, Ohio.



Ram descends to shear four slots, then holds down under full pressure as side cylinder advances broach for .050 slot. Chips are trimmed at next ram station.



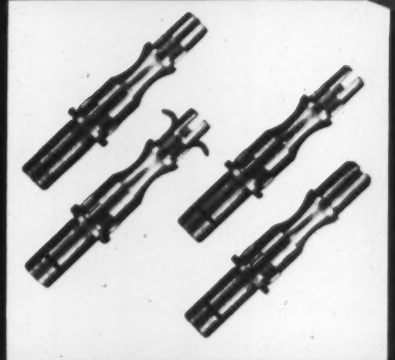
Next, spindle receives hopper-fed sleeve under transfer mechanism. Sleeve is pressed over spindle end by a cylinder activated by descending ram.



In final operation, spindle is clamped and center hole reamed through by drill head. Flange-mounted cylinder then ejects spindle from fixture.

hydraulically

8-ton hydraulic Multipress equipped with 12-station index table. Index table is mounted over special bolster on 22-inch work circle, to which is attached one-ton capacity, foot mounted hydraulic cylinder with 12-inch stroke.



Various machining stages illustrated: (left to right) spindle prior to slotting; after shearing slots, showing chips; after trimming of slots; with sleeve pressed into place.

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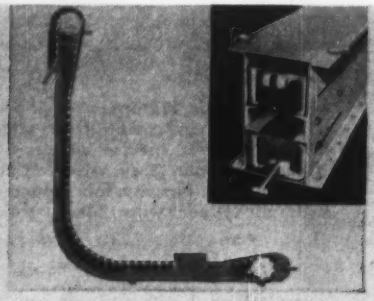
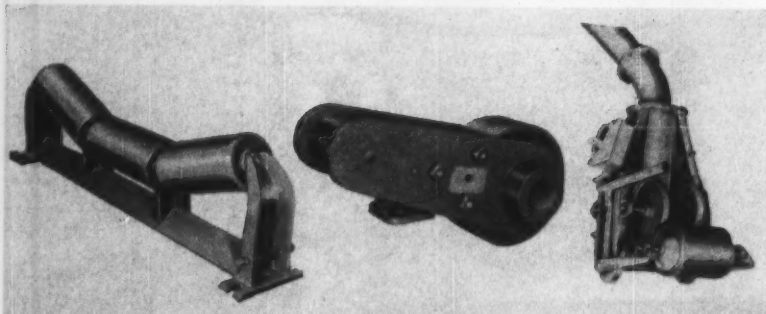


REDLER CONVEYOR-ELEVATORS

Standard Products Division

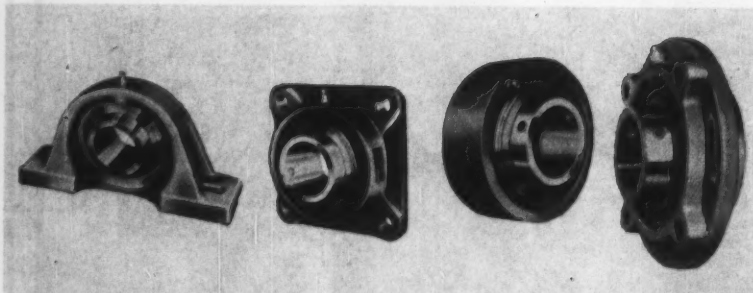
S-A standard products include a wide range of "in stock" equipment, sold through industrial distributors all over the U.S.A. These products are designed to handle a variety of assignments in the movement of bulk materials in the mining, industrial, and agricultural fields. Each standard S-A product is scientifically designed to give long, trouble-free service under even the most adverse conditions. They are designed to provide automatic material handling, speed production and save costly man hours.



CARRIERS HOLD BACKS SWIVEL PILERS

Sealmaster Division

Sealmaster Bearings are available in a number of basic designs. They have exclusive engineering features which have firmly established superior standards of maximum bearing efficiency and low cost maintenance. Sealmaster Ball Bearing Units are in daily use in standardized applications on machinery and transmission equipment in mining, industrial, and agricultural fields. These units are permanently sealed, self-aligning, and pre-lubricated. Exclusive zone hardening permits race-to-shaft locking.



PILLOW BLOCK FOUR BOLT FLANGE CARTRIDGE FLANGE CARTRIDGE

CATALOGS ON ALL S-A PRODUCTS ARE AVAILABLE ON REQUEST

S-A **STEPHENS-ADAMSON MFG. CO.**

ADAMSON

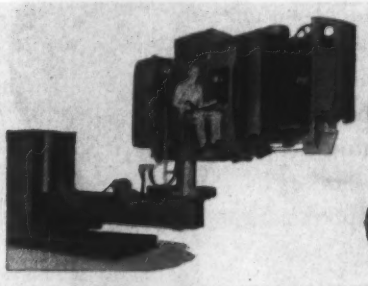
bulk materials handling equipment

MATERIALS HANDLING REQUIREMENTS

BUCKET ELEVATORS

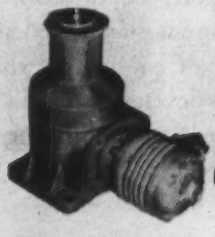
KNITTLE CRUSHERS

VIBRATING SCREENS

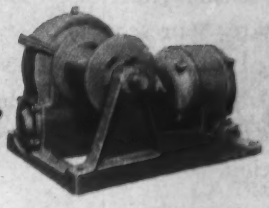


BOXCAR UNLOADERS

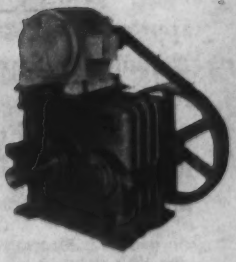
BIN LEVEL CONTROLS



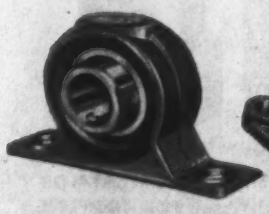
CAR PULLERS



WINCHES



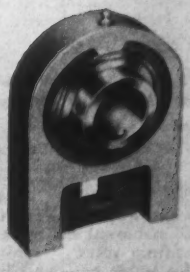
SPEED REDUCERS



RUBBER MOUNTED PILLOW BLOCK

TWO BOLT FLANGE

HANGER



SPECIAL BALL BEARING UNIT

SPHERCO BEARINGS AND ROD ENDS

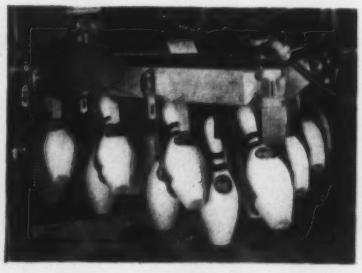
Manufacturing Plants:
19 RIDGEWAY AVENUE, AURORA, ILLINOIS/LOS ANGELES, CALIFORNIA/BELLEVILLE, ONTARIO
Sales Representatives In All Major City Areas

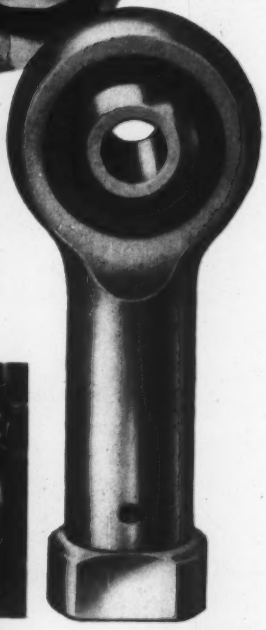
automation *with* HEIM *Unibal*

America's greatest participant sport, tenpin bowling, is played by approximately 20 million Americans on more than 60,000 alleys. The AMF Automatic Pinspotter represents a piece of equipment which all bowling for years has hoped would eventually be developed. It is a fully automatic unit for setting tenpins, returning the ball, accomplishing all pit services now done by hand, but with greater efficiency. More than 5,000 Pinspotters are now in operation.

In the AMF Pinspotter, Heim Unibal Rod Ends are used on the Pantograph bars which guide and stabilize the spotting table during its cycle of up and down drive. They are also used to drive the sweep mechanism and on the sweep carriage. The major application of the Heim Rod Ends on the Pinspotter is where it is employed in a shock-absorbing link arrangement to raise and lower the table. Here it is subjected to lifting a load of approximately 350 pounds.

THE ABILITY OF THIS JOINT TO COMPENSATE FOR MISALIGNMENT AND MAINTAIN FREEDOM OF ROTATION MAKES ITS USE ON THE PINSPOTTER VERY SATISFACTORY





The HEIM Unibal is the original Spherical Bearing developed, engineered, and manufactured by The Heim Company for nearly fifteen years. It consists of a single ball (instead of a single or double row of balls) rotating in an outer member, and supported by bronze bearing inserts which act as the race.

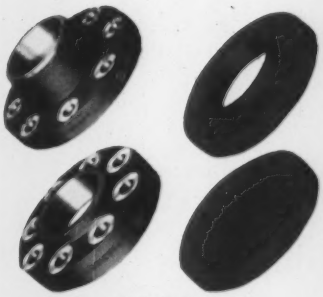
For center shaft or end support, the outer member is cylindrical in shape and made in a wide range of sizes. As a rod end for the transmission of power or motion at varying angles, the outer member is made with lubrication groove, in either male or female design, and with lubricator fitting if required.

SEE THE NEW HEIM CATALOG FOR COMPLETE LIST OF SIZES

THE HEIM COMPANY

FAIRFIELD, CONNECTICUT

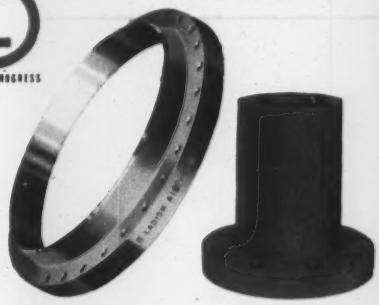
IPS—BUTT WELDING FITTINGS
½"-42" From Sch. 5S to 4" Walls



ASA and MSS FLANGES
½"-24" 150 through 2500 lbs.

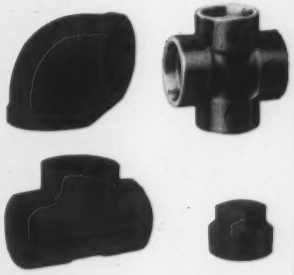
TO MARK PROGRESS

TUBE O.D.—BUTT WELDING FITTINGS
½"-36" From .049" to .250" Wall



LARGE O.D. and TEMA FLANGES
Up to 20' in Diameter
LONG WELDING NECKS
1"-24" 150 through 2500 lbs.

UNIONS
⅛"-4" 150 lbs. and 2000 through 6000 lbs.



SCREWED and SOCKET FITTINGS
⅛"-4" 150 lbs. and 2000 through 6000 lbs.

LADISH

FOR *Complete Service* IN *Controlled Quality*

FORGED AND WROUGHT FITTINGS

CARBON • ALLOY
STAINLESS STEELS
AND ALUMINUM

WHATEVER your fittings requirements . . . regardless of the type, size, wall thickness, pressure rating or material specification . . . you can get prompt, efficient, *complete service* by specifying LADISH and ordering from your local Authorized Ladish Distributor.

A broad, full-range line produced to unsurpassed standards of metallurgical and manufacturing integrity . . . plus adequate distributor stocks . . . gives you double assurance of satisfaction.

For complete service on your fittings requirements . . . call your Authorized Ladish Distributor.

Catalogs available on request. Please indicate specific product lines for which information is desired.

THE COMPLETE *Controlled Quality* FITTINGS LINE

LADISH CO.

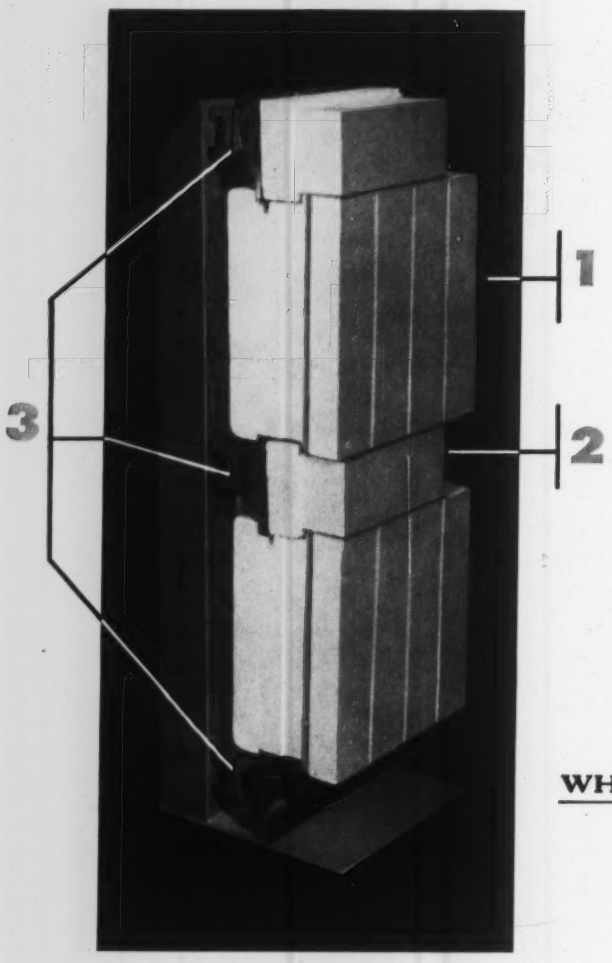
CUDAHY (Milwaukee Suburb) WISCONSIN

District and *Regional Offices: New York • *Baton Rouge • Buffalo • Pittsburgh • Philadelphia • Cleveland • Chicago • St. Paul • St. Louis • Atlanta • Houston • *Odessa • Tulsa • Denver • Los Angeles • *San Francisco • *Seattle • Havana • Mexico City • Brantford, Ont.

IDEA FILE:

Big problem these days is saving money on capital goods equipment —without sacrificing performance. A combination of ideas from Bigelow-Liptak's engineering department involves the use of two established wall designs • • •

LIKE THIS:



IDEA and SAVING NO. 1

Use a seven-inch tile for maximum refractory thickness.

IDEA and SAVING NO. 2

Employ a five-inch filler tile. (Place insulation or fire clay in front of supporting casting.)

IDEA and SAVING NO. 3

Increase space between horizontal castings and eliminate a number of castings.

and – for FLEXIBILITY

Air cool the wall—or use economical thicknesses of block and plastic insulation depending upon temperature requirements.

WHERE THIS DESIGN IS USED:

For refinery oil heaters, municipal incinerators or power plants where economy is a must, but where performance has got to be good. Write for details.

BIGELOW-LIPTAK
CORPORATION
AND BIGELOW-LIPTAK EXPORT CORPORATION
13300 PURITAN AVENUE, DETROIT 27, MICHIGAN

UNIT-SUSPENDED WALLS AND ARCHES

IN CANADA
BIGELOW-LIPTAK OF CANADA, LTD.
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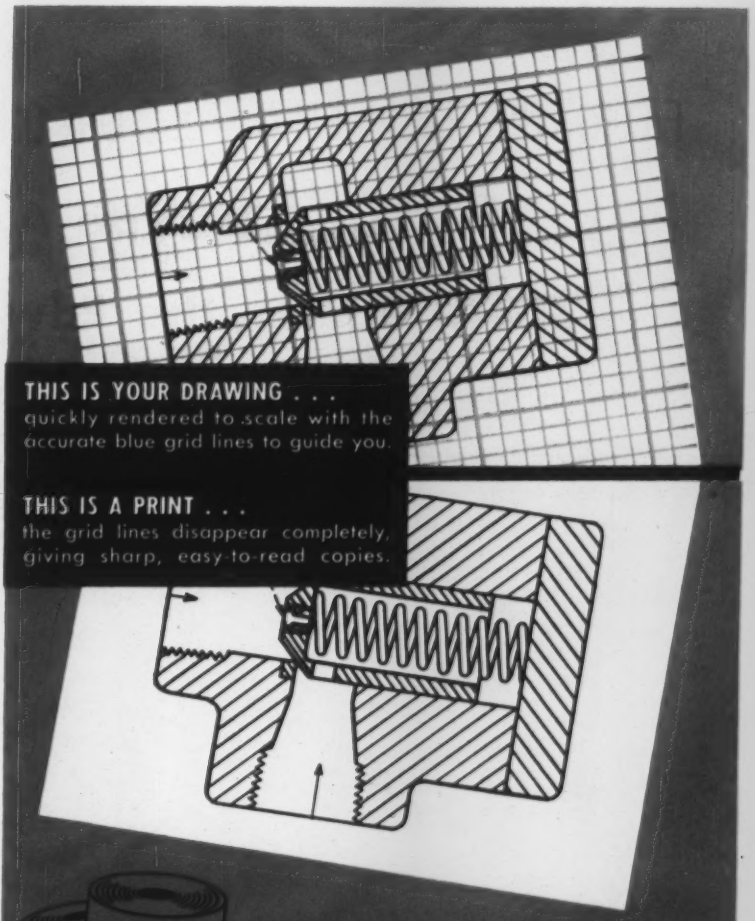
Leading engineers and designers report that Clearprint Fade-Out Paper speeds up their drafting 10 to 15% . . . cuts their costs proportionately. And Fade-Out Paper gives them prints which are sharper and easier to read, because grid lines do not reproduce.

Clearprint's perfect working surface invites pencil and pen — lines are sharp and clean. It withstands repeated erasures, too, without the slightest ghosting.

See how Clearprint Fade-Out Paper can solve *your* drafting problems. Order a trial roll now, and apply it to your various drawing needs.

Available with grids ruled 4x4, 5x5, 8x8 and 10x10 lines to the inch.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quickly rendered to scale with the accurate blue grid lines to guide you.
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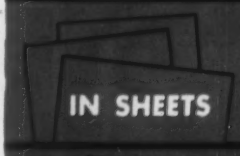
the grid lines disappear completely, giving sharp, easy-to-read copies.



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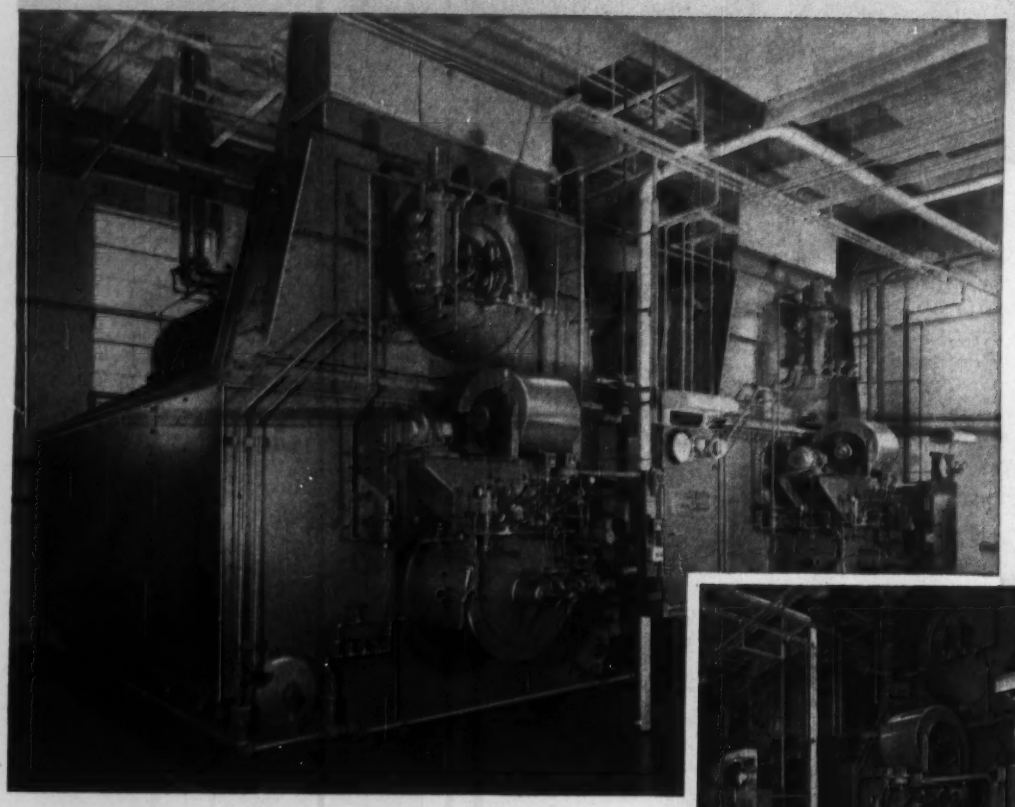
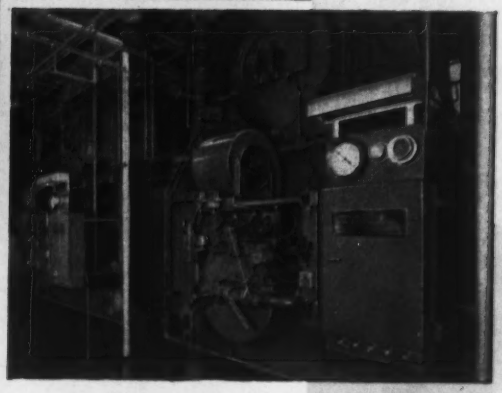
FOR UNFAILING, ECONOMICAL SERVICE,

WICKES Type A, shop-assembled specified for the Edward W. Sparrow

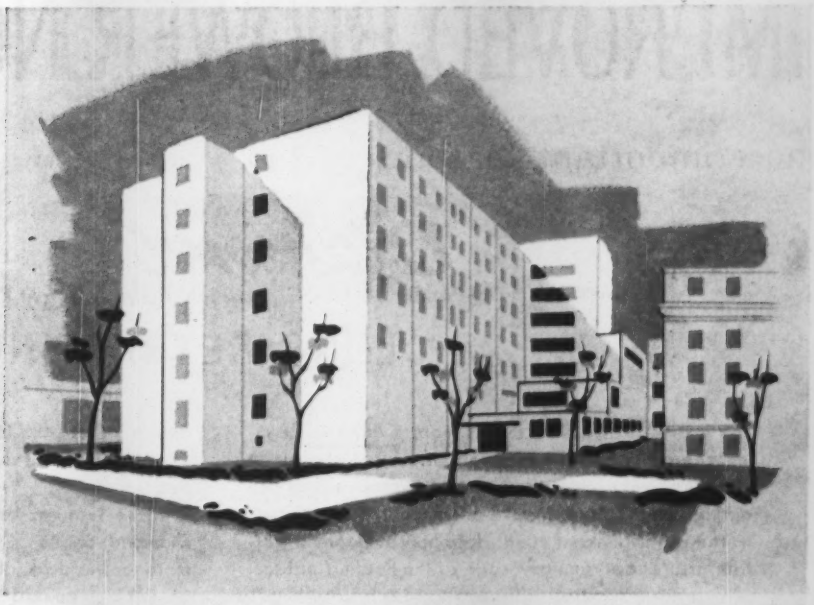




Wickes Type-A Steam Generators combine custom engineering and shop-assembly to give you economical "packaged power" to exactly meet the load requirement. The entire unit is shipped complete ready to set on your foundation and installation can be made with minimum interruption of your production schedules. All necessary auxiliary equipment including trimmings, soot blowers, feed water regulators and other accessories, are shop-installed leaving field installation at a minimum. From the pressure-tight casing to the oil-gas burner, Wickes type-A water tube steam generators with capacities up to 60,000 lbs. of steam per hour are designed and engineered to be the standard of quality and performance in a variety of industries.

boilers are

hospital



Architects sketch of new Sparrow Hospital.
Architects: O. J. Munson Associates–Lansing, Michigan.
Professional Engineers: E. Roger Hewitt Associates, Inc.–Lansing, Michigan.

One of the most important considerations in hospital construction specifications is the steam generation system, because it must give around-the-clock reliability without failure. It is significant, then, that for the Edward W. Sparrow Hospital in Lansing, Michigan, two Wickes shop-assembled Type-A Steam Generators have been installed to provide a dependable source of heat. The new units, which are housed, in a completely new boiler house, replace the original Wickes coal fired boilers. Each of these two new boilers are capable of producing 18,500 lbs. of steam per hour at an operating pressure of 125 psi. They provide 2250 square feet of heating surface and are equipped with fully automatic Wickes combination oil and gas burners. These units have a design pressure of 160 psi.

Write for our Catalog 56-1 for detailed information on Wickes Type-A Boilers, and we will also include our Bulletin 55-1 covering the complete line of Wickes Products and Facilities.

WICKES

THE WICKES BOILER CO.

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

RECOGNIZED QUALITY SINCE 1854 • *SALES OFFICES:* Albuquerque, N.M. • Boston • Buffalo • Charlotte, N.C. • Chicago Cleveland • Dallas • Denver • Detroit • Fort Wayne, Ind. • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee New York City • Portland, Ore. • Saginaw • Salt Lake City • San Francisco • Springfield, Ill. • Tulsa • Washington, D.C.

IMPROVED BLOWER NOZZLE and

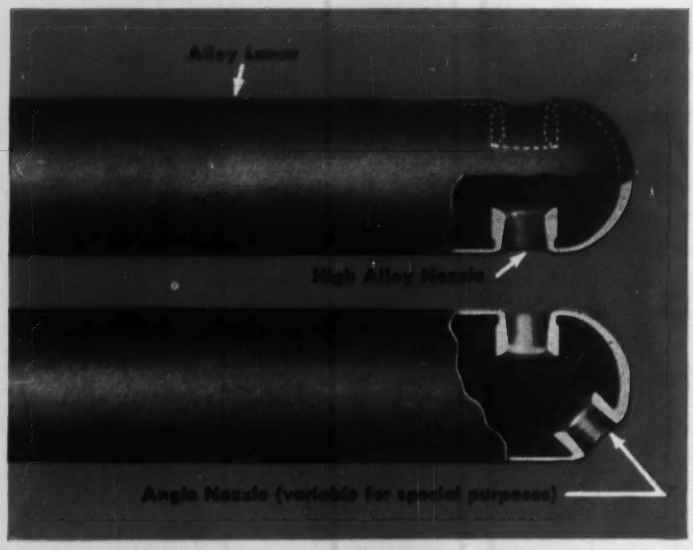
more important features of the

New Diamond Series 300 IK
LONG RETRACTING BLOWER

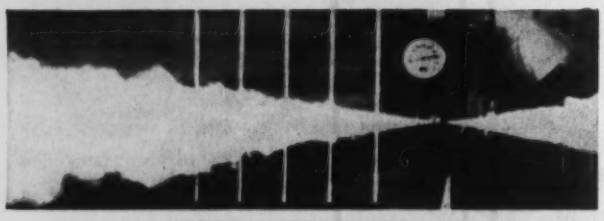
This improved nozzle provides more available cleaning energy per pound of steam or compressed air. A modified venturi, it is the result of extensive research during which more than 50 contours were tested.

The positively-controlled, close helical cleaning pattern assures optimum coverage of the heating surface. Return travel path is exactly intermediate to forward travel path . . . resulting in a positive nozzle sweep every inch.

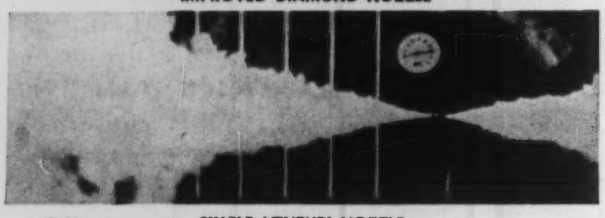
These features are two of many reasons why the Diamond Series 300 IK Blower does a better and more economical job of cleaning surfaces which require a long retracting blower. Other advantages are listed at the bottom of the opposite page. Ask the nearest Diamond office for Bulletin 2111AA which will tell you much more about the new Series 300 IK.



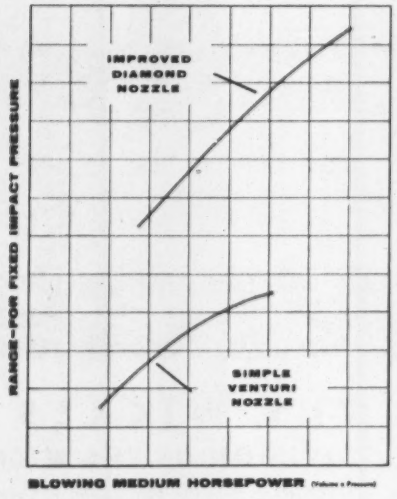
Improved Diamond Type "A" Nozzle has low approach velocity for optimum nozzle performance (see curves below). It provides greatest impact for any given blowing pressure . . . means greater effectiveness and economy.



IMPROVED DIAMOND NOZZLE

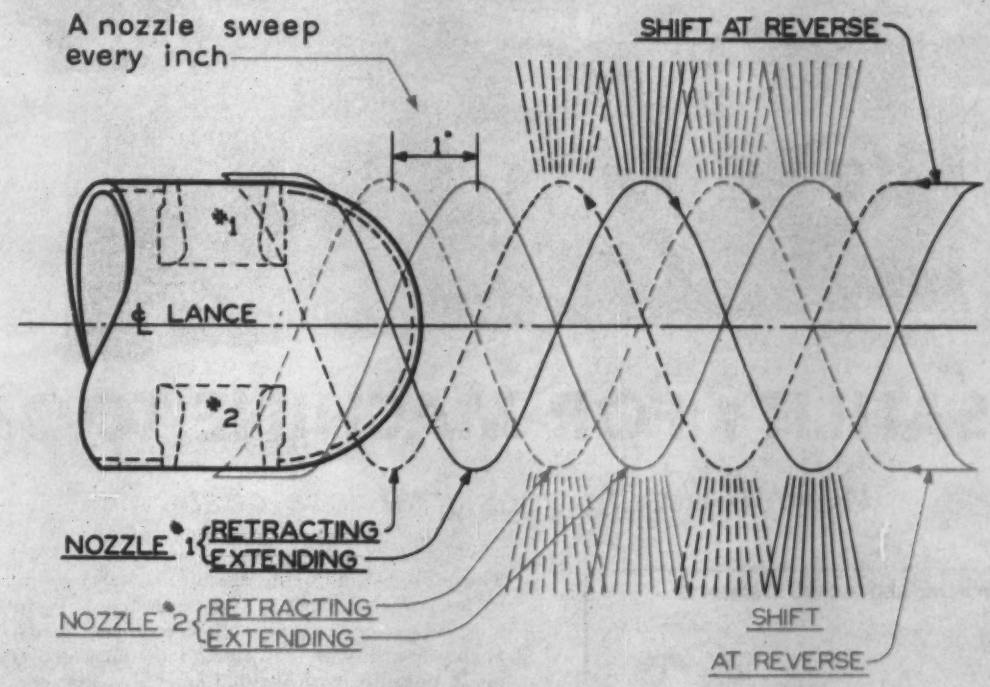


7818 SIMPLE VENTURI NOZZLE



Note the greater blowing range of the improved Diamond Nozzle when compared with a simple venturi nozzle under identical test conditions.

IMPROVED CLEANING PATTERN



Nozzle-sweep-every-inch blowing pattern assures COMPLETE coverage of ALL surface EVERY time

OTHER ADVANTAGES OF SERIES 300 IK BLOWERS

- Backbone and Protective Cover
- Front End Single-Motor Drive
- Compact, Accessible Electric Power and Control Terminal Facilities
- Positive Gear Carriage Drive
- Poppet Valve with Adjustable Pressure Control
- Positive Mechanically Operated Valve
- Single Point Outboard Suspension
- Oversize Lance (Step-Tapered for Extra Long Travel)
- Auxiliary Carriages for Extra Long Travel
- Designed for Quick, Easy Servicing

No other blower gives you all these advantages.

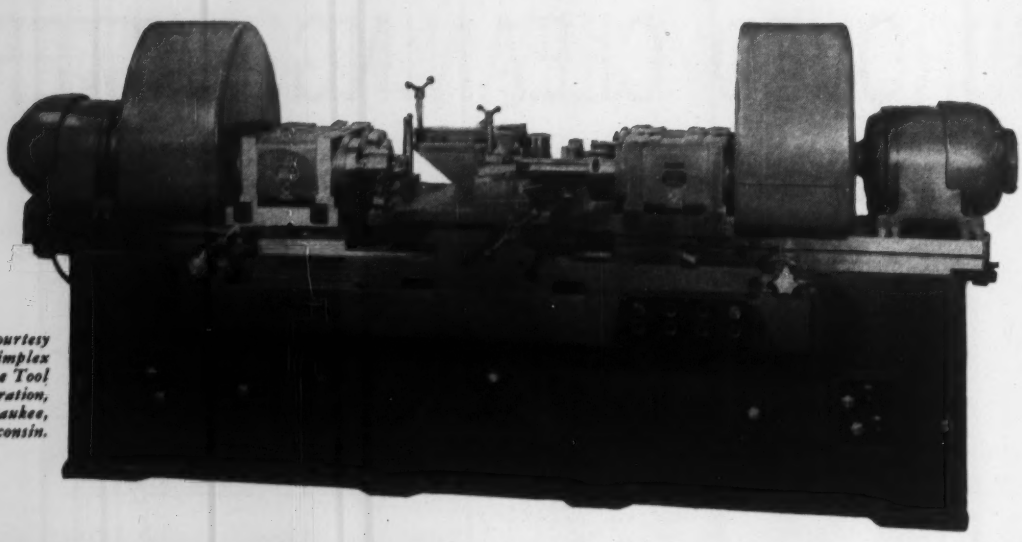
Diamond

DIAMOND POWER SPECIALTY CORPORATION

LANCASTER, OHIO

Diamond Specialty Limited

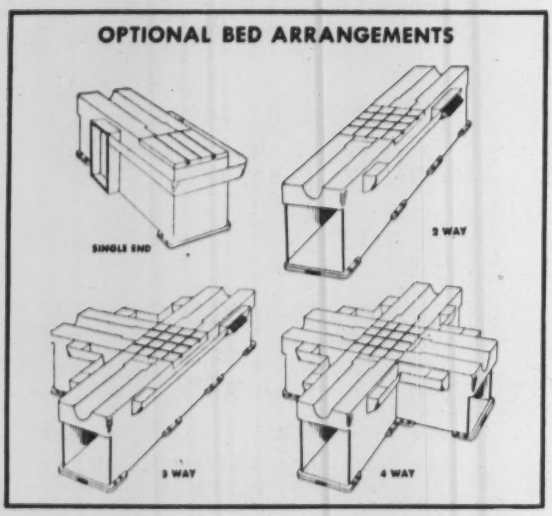
Windsor, Ontario



Photos courtesy of Simplex Machine Tool Corporation, Milwaukee, Wisconsin.

VERSATILITY FOR MACHINE TOOLS

Welded design does it at less cost



These precision boring machines can have one to four boring heads. The beds may vary in length . . . depending on the customers' needs. Such versatility in design and manufacture is made possible with welded steel . . . because:

- **A welded base design can be easily and quickly modified since there are no patterns involved.**
- **Less material is needed since steel is three times stronger than iron, 2½ times as rigid . . . yet costs a third as much per pound.**
- **Less machining, less finishing is needed.**

Basic advantages like these can be applied to many products. A Lincoln engineer who is backed by 45 years of Lincoln cost-cutting experience, will gladly show you how to benefit.

Write for Weldesign Bulletin, available to product designers.

THE LINCOLN ELECTRIC COMPANY

Dept. 4816, Cleveland 17, Ohio

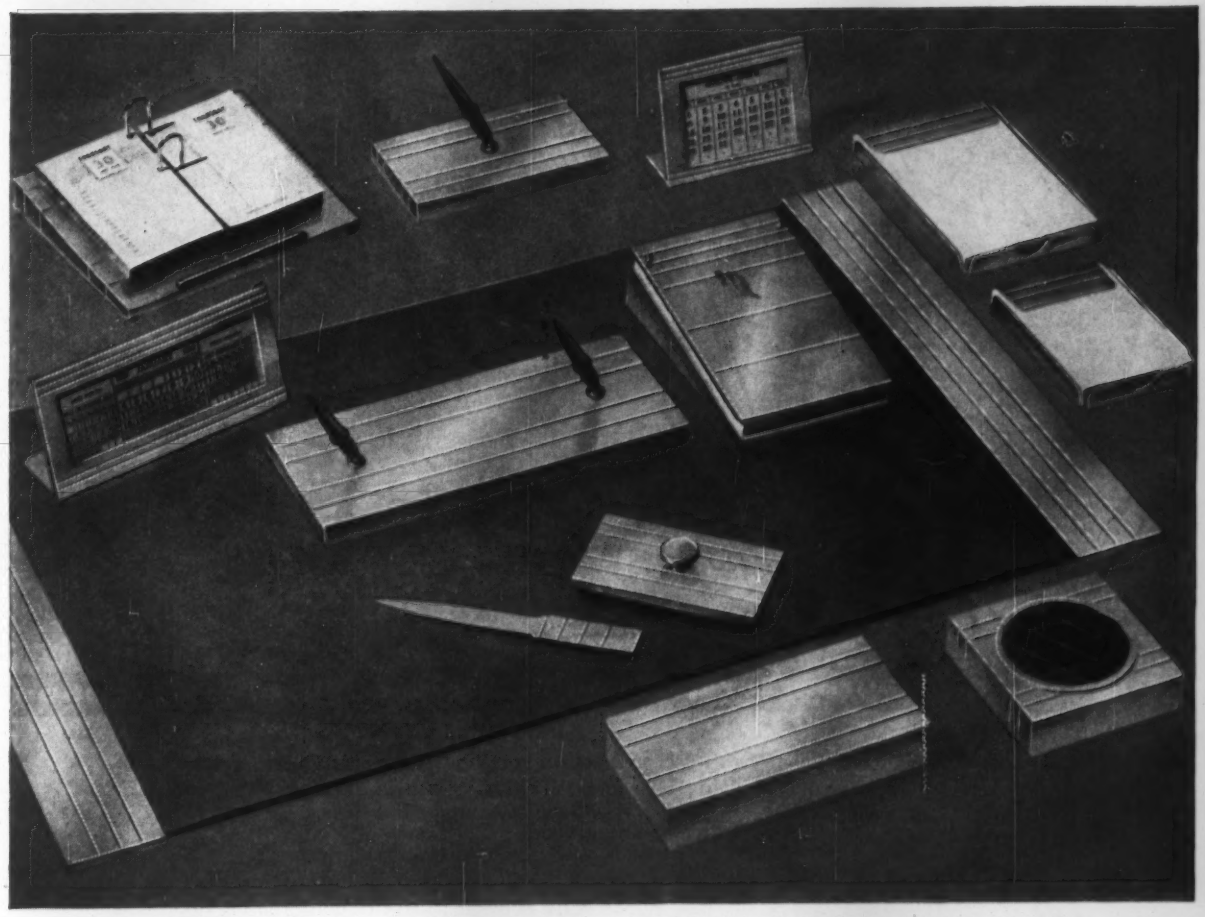
The World's Largest Manufacturer of Arc Welding Equipment

When steel is three times stronger than iron

Has much more versatility

Yet costs much less

WHY aren't your products designed for welded steel?



A few of the fine executive desk appointments made of Formbrite by Smith Metal Arts Co., Inc.

For a superfine luster that lasts—superfine-grain Formbrite

Smith Metal Arts Co. uses easy-to-polish, scratch-resistant Formbrite to add value to its line of distinguished desk appointments.

The fine executive desk appointments made by Smith Metal Arts Co., Inc., Buffalo, N. Y., are not just polished to shine. They are brought up to a beautiful deep luster. For their line of brass accessories they use Formbrite,® Anaconda's superfine-grain drawing brass.

They have found that the fine, uniform grain size of Formbrite enables them to give their pieces a superior, more uniform texture. The luster, furthermore, stands up better under handling because Formbrite provides a harder, more scratch-resistant surface.

In order to achieve this fine luster, Smith Metal Arts Co. must do an exceptional amount of polishing and they have chosen Formbrite because of its superior polishing characteristics. By using Formbrite they can achieve their high quality surfaces at savings of 20% over the use of ordinary brass.

See for yourself. Formbrite is a premium product at a nonpremium price. Find out for yourself how its superfine grain, excellent drawing properties, strength, and scratch resistance can help you improve product quality, lower finishing costs. Write for Publication B-39. Better yet, ask for a sample or details on our trial order offer. Address: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

5771

Formbrite

SUPERFINE-GRAIN DRAWING BRASS

an ANACONDA® product

Made by The American Brass Company

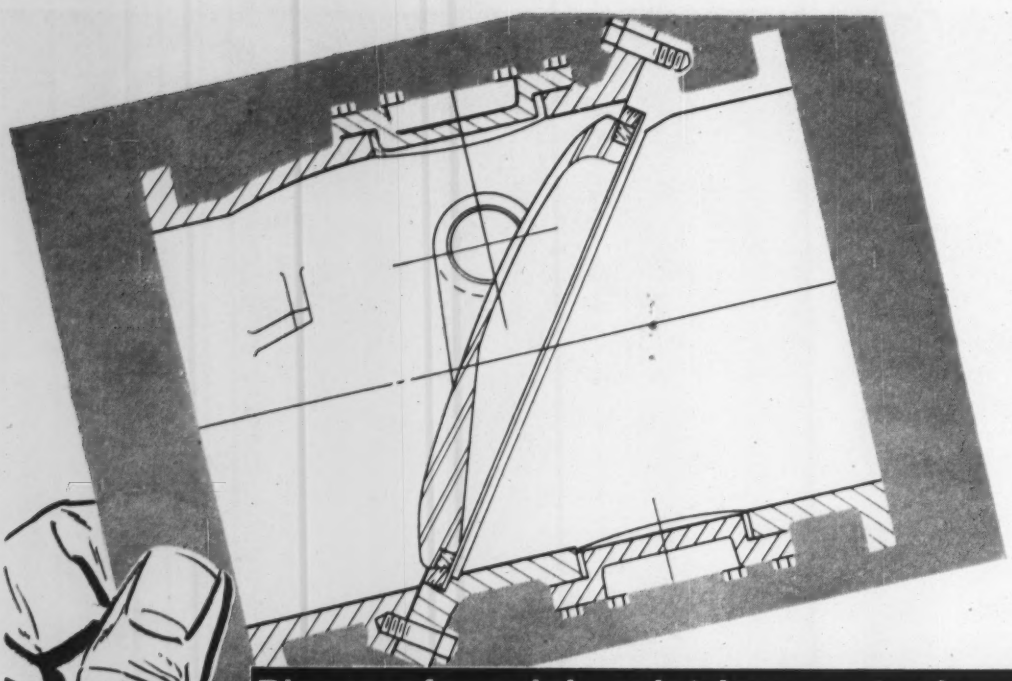


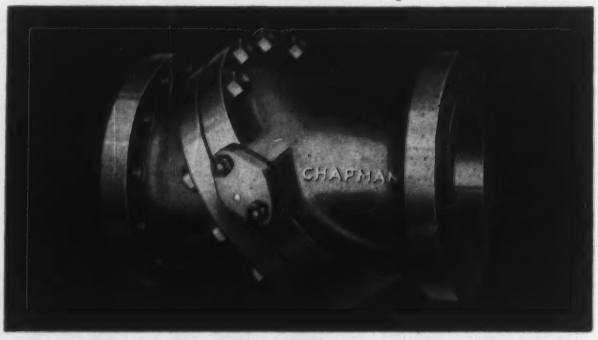
Diagram for quick, quiet, low-cost valve operation

Here's the picture . . . a cross section showing the working principles of the Chapman Tilting Disc Check Valve. It makes sense. It's a clear-cut diagram of a way to save dollars.

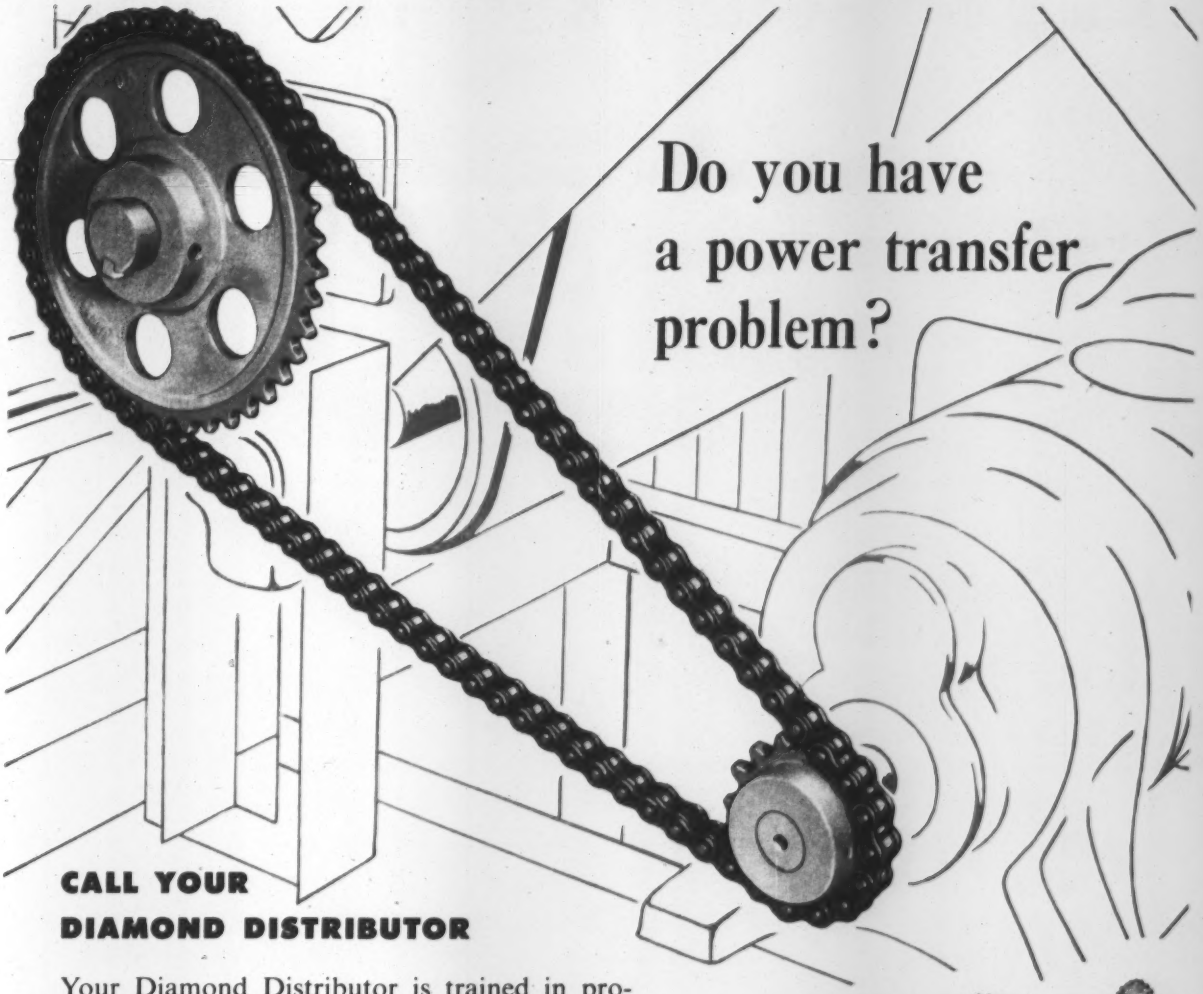
Notice the body design — plenty of room allowed to eliminate flow resistance, and the balanced "Airfoil" disc supported on a pivot. When the flow is on, disc opens wide enough to meet the demands of the flow. When the flow is off, disc drops quickly to a firm, tight seat. This is not only quick operation . . . it's quiet operation. There's no flutter. No banging. No slamming. No scraping of disc and seat. All this, of course, means low-cost operation. There's nothing to cause wear and tear or damage to valve or system. Your maintenance costs are low even under severe conditions.

CHAPMAN
Tilting Disc Check Valve

For best results in handling fluids or gases at the lowest cost, specify Chapman Tilting Disc Check Valves. They cover a wide range of pressures and are available in iron or steel. You'll find them all with complete data in our Catalog 30-A. Write for your copy, now.



The CHAPMAN
Valve Manufacturing Co.
INDIAN ORCHARD, MASSACHUSETTS



Do you have a power transfer problem?

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Your Diamond Distributor is trained in providing Diamond Roller Chain drives to meet the toughest kind of specifications and requirements.

He carries stocks of Diamond roller chains, sprockets and couplings to give you quick service. His roller chain application experience can improve drive performance, efficiency and save you money.

Call your Diamond man now. His name is in the classified section of your local telephone directory under the heading **CHAINS** or **CHAINS-ROLLER.**

DIAMOND CHAIN COMPANY, Inc.,
Dept. 413, 402 Kentucky Avenue,
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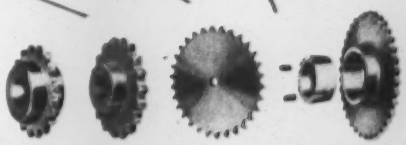
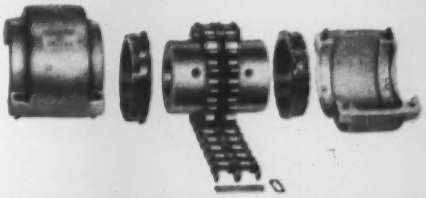
Offices and Distributors in All Principal Cities
Write for New Catalog 757.



Diamond Sprockets are stocked in all standard types including finished bore and taper-lock sprockets for maximum availability through your Diamond Distributor.



Diamond all-steel Flexible Couplings and Casings for end-to-end shaft connections absorb moderate shaft end play and misalignment. They are easily connected and disconnected.

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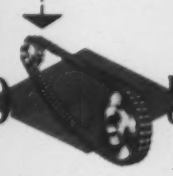
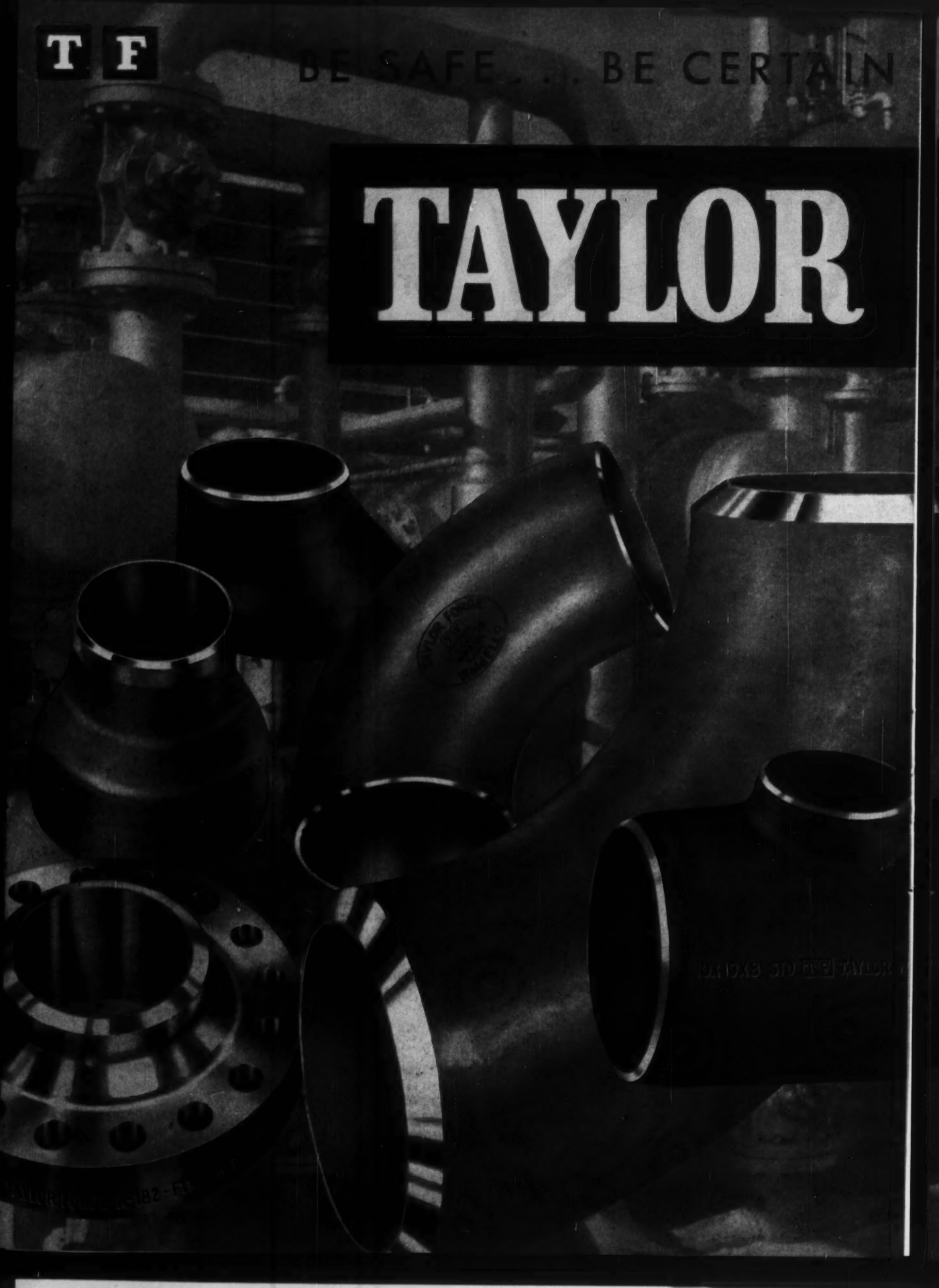


DIAMOND ROLLER CHAINS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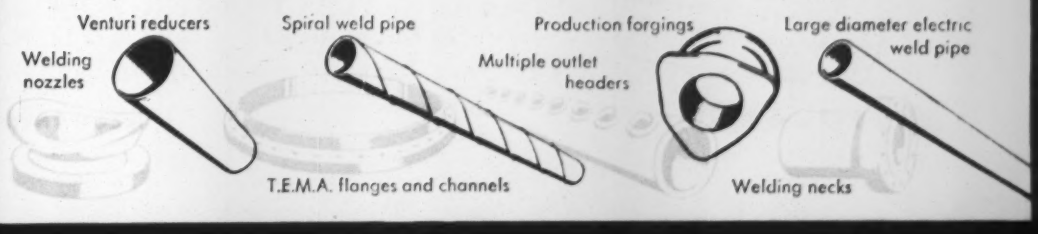

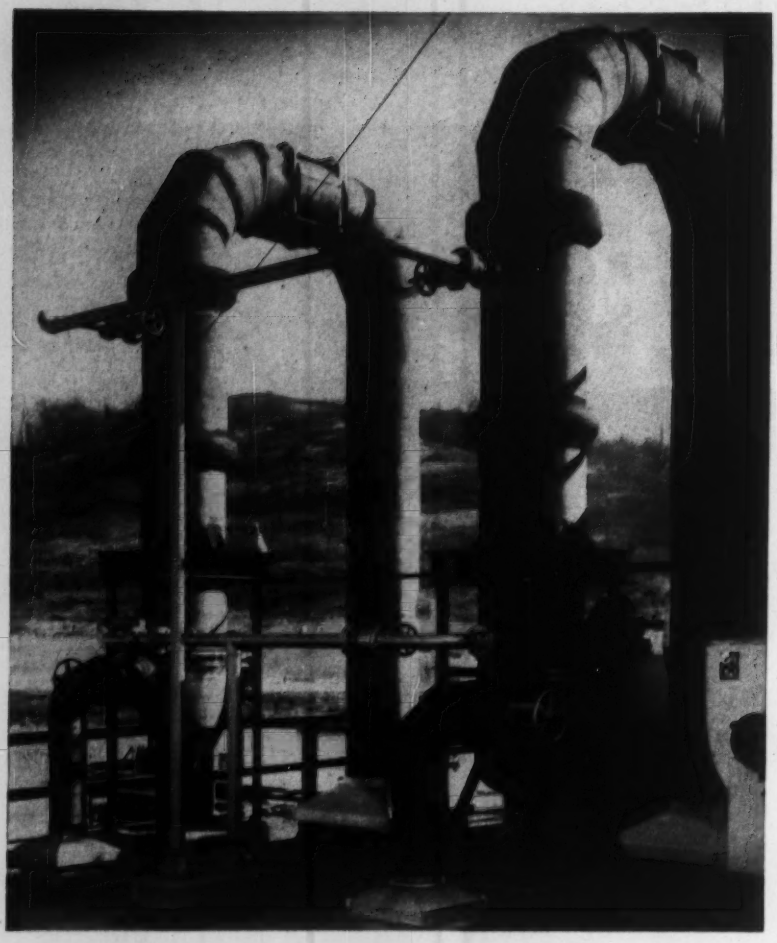

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NICKEL HEAT EXCHANGERS FROM

ALBERGER

The new Moundsville, West Virginia, plant of National Aniline Division, Allied Chemical & Dye Corp., has some of the most modern chemical processing equipment to be found anywhere in the world. Among this equipment are many Alberger Heat Exchangers, of which two are shown above as the left part of each inverted U.

The two heat exchangers are identical. Tubes, tube sheets and end sections are of nickel to handle the end product of the plant—diisocyanates. Shells with expansion joints are of carbon steel.

The final product enters the heat exchangers at the top as a gas and flows out of the exchanger as a liquid through the elbows at the left. The gas is condensed by cooling water entering and leaving the shell through the narrow silvered piping.

The axial thermal expansion of piping and heat exchangers is absorbed by nickel anti-compression expansion joints shown at the top of each inverted U. These joints were engineered and manufactured by American District Steam, which, like Alberger, is also a division of Yuba Industries, Inc.

Alberger has made 40,000 installations since its founding 53 years ago. Its engineers would be pleased to consult with you regarding heat exchangers.

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BOSTON Gear STANDARDIZED STOCK VARIABLE SPEED DRIVES

BOSTON VARIABLE SPEED DRIVES

Assembly consists of a self-contained, spring-tension Motor Pulley, a Flat Face Driven Pulley, a heavy duty Belt, and an Adjustable Motor Base. The self-contained design of the Motor Pulley provides a patented safety-lock feature which prevents accidental release of the spring when the disc assembly is removed.

BOSTON VARIABLE SPEED REDUCTOR DRIVES

Consists of above described parts with addition of a BOSTON 100 Series Reductor, — Type U, TW, V, or VW. Illustration (right) shows Variable Speed assembly with Type TW Reductor, used with BOSTON Sprockets and Chain to drive conveyor belt of heat-treating furnace.

ADJUSTABLE MOTOR BASE

A ruggedly proportioned sliding platform, with accurately machined dovetail ways, lead screw, and nut for positive control and vibrationless, noise-free operation. Sold separately, this base is also widely used for many other applications requiring an adjustable motor mounting.

Designed for use with ½ and ¾ HP motors, to provide infinitely variable, 3 to 1 speeds. Speed changes can be made while the drive is running. Output torque ratings remain constant throughout the speed variations. Any driven shaft speed range needed, between 1750 RPM and .5 RPM, can be provided with the use of STANDARDIZED STOCK parts.

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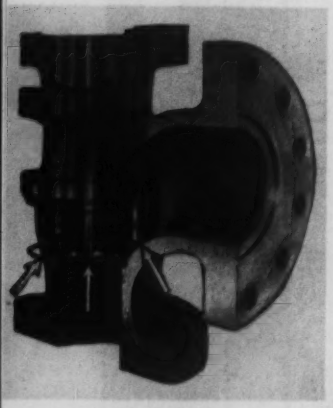
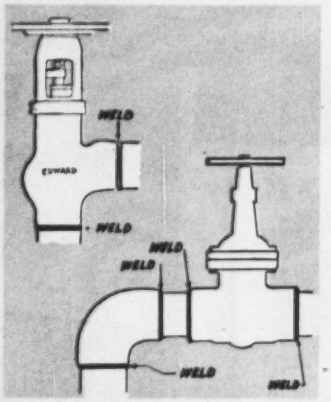
How To Get The Most

Tips on selection, installation and operation of steel



INTERNALLY-GUIDED VALVES MORE EFFICIENT

Internally-guided stop, check, and non-return valves are more efficient if the disk centers into the seat for positive shut-off. Illustration shows typical Edward check valve with three integral guide ribs.

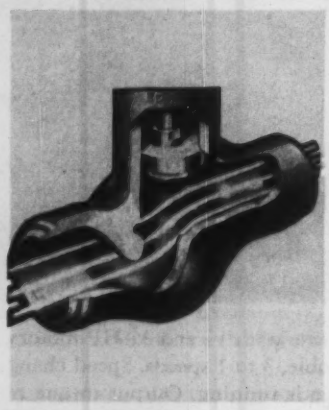


ANGLE VALVES REDUCE INSTALLATION COST

An angle stop valve can often be used instead of an elbow and a globe or gate valve. This reduces installation cost, makes bends, elbows and other components unnecessary, minimizes pressure drop.

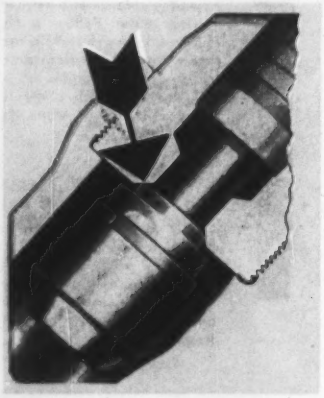
STREAMLINING CUTS FLOW RESISTANCE

Internal streamlining, carefully designed and executed, cuts turbulence . . . reduces pressure drop . . . minimizes wear. Working with experimental half-models and the most modern laboratory equipment, Edward scientists incorporate the most precise streamlining in every valve.



BACKSEAT ISOLATES PACKING CHAMBER

Stop, non-return and blow-off valves can actually be repacked under pressure if they have a positive backseat, as illustrated. Here, a radiused disk nut contacts beveled bonnet seating surface, isolates packing from line pressure. This feature also protects packing, and reduces maintenance.



WELDED BONNET CAN'T LEAK

Ideal for severe service applications, small forged valves with welded bonnets are virtually leak-proof. This construction permanently maintains pressure tightness—eliminates need to periodically restress bolts. Weld can be removed, however, if internal repairs are ever necessary.

HERE'S BEST WAY TO BLOW DOWN

To begin blow-down, open wide the valve nearest boiler—then open second valve. To stop blow-down, reverse procedure by closing second valve first—then close valve nearest boiler. This puts greatest wear on second valve, which can be repaired or replaced *without shutting down boiler.*

Rockwell-Built Edward Valves

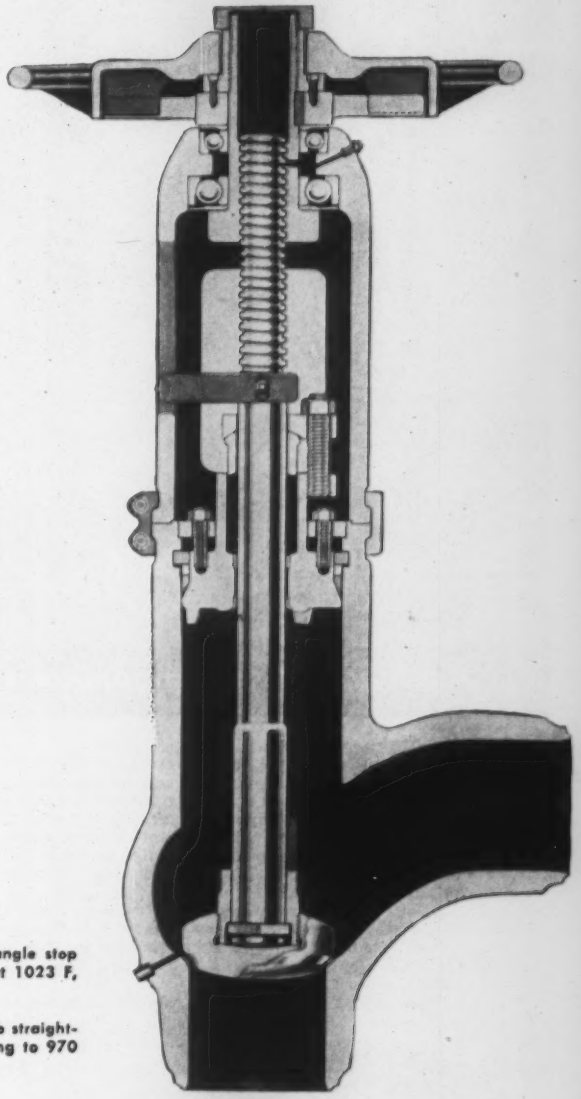
Value From Steel Valves

valves from Edward, long-time leader in the field

One way to cut the cost of initial installation—and future maintenance expense—of a piping system is to select the *right* steel valves. A competent valve engineer, for example, can often indicate where one angle stop valve can replace both an elbow and a globe or gate valve . . . reducing the costs of installation *and* cutting the number of piping components required. Other typical "secrets" of obtaining greater value from steel valves are shown in convenient clip-out form on the opposite page.

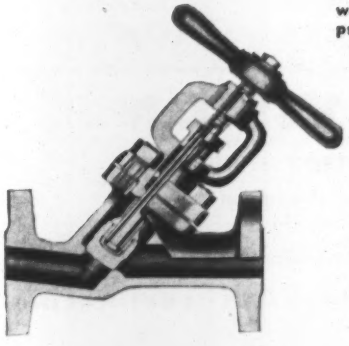
While he is well acquainted with piping conditions, a valve engineer concerns himself primarily with valves and their functions—and in this field, he is an acknowledged expert. His field experience, plus access to the results of continuous laboratory research, can put at your disposal a wealth of information on valve selection, installation, operation, maintenance and repair.

Such a man is your Edward Valve Representative. Technically trained, thoroughly experienced, his professional advice can save you headaches and money. At his disposal and yours are the results of continuing substantial investments in steel valve research. Many features, now accepted as standard in valves, were actually introduced by Edward. This process of constant development is reflected in Edward Valves . . . and in the spirit of your Edward Representative! He is at your disposal, to help you obtain the *most* for your valve dollar—both now and in the future. A card or a call will bring him . . . why not get in touch with us now?



Right: Fig. 7517Y cast steel 1500 lb angle stop valve for steam services to 1500 psi at 1023 F, water to 3600 psi at 100 F.

Below left: Fig. 641 forged steel 600 lb straightway blow-off valve for boilers operating to 970 psi saturated drum pressure.



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IN AN AUTOMATIC WASHER HELPS BUILD CUSTOMER SATISFACTION -YET COSTS NO MORE
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OILITE bronze thrust washers (2)
OILITE bronze pulley bearing
OILITE bronze water pump bearing
Photos courtesy Whirlpool-Seeger Corporation St. Joseph, Michigan
Another cost-saving application of Amplex Powder Metallurgy

Quality is a *must* for trouble free operation, continued customer satisfaction. And quality depends upon the excellence of every part, every component. For many years Whirlpool-Seeger has used OILITE center post bearings, agitator shaft bearings, water pump bearings and pulley bearings in their automatic washers. Whirlpool-Seeger uses these and other OILITE parts for very good reasons.

First of all, the manufacturer knows OILITE heavy-duty bronze bearings will meet specifications. Chrysler-Amplex precision production assures him OILITE bearings capable of carrying their loads safely, surely and quietly.

Then too, Chrysler-Amplex plant and facilities—largest and most complete of any in the metal powder fabrication industry—promises on-time deliveries in any quantity.

Moreover, in using OILITE bearings the manufacturer selects a product his customers know and respect for superior engineering.

Finally, this manufacturer, like a great many others, finds OILITE bearings—despite all their advantages—cost no more.

Chrysler-Amplex representatives and dealers are located in principal cities in United States and Canada. Let the nearby representative help you. Find him in the yellow section of your telephone directory under—"Bearings—OILITE."

OILITE

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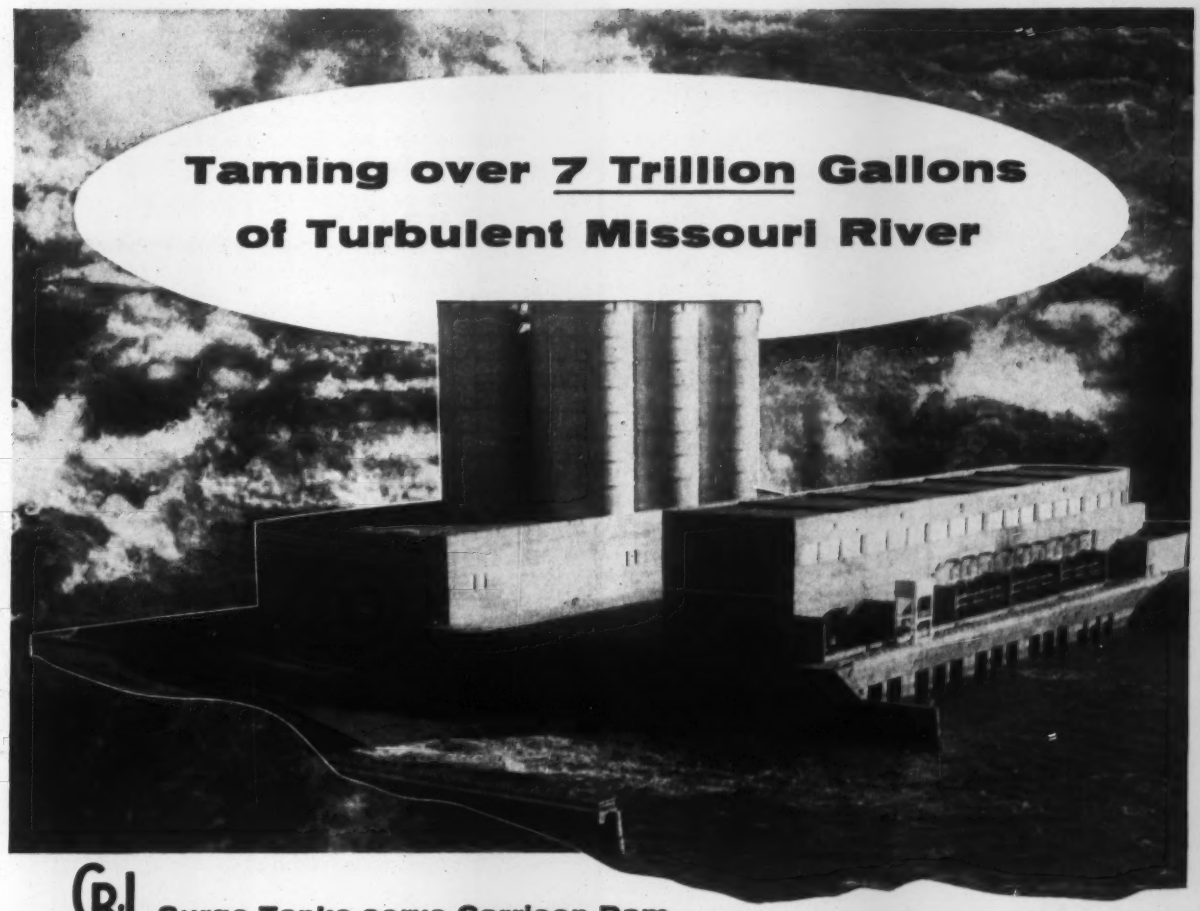
BEARINGS • FINISHED MACHINED PARTS • PERMANENT METAL FILTERS • FRICTION UNITS • FERROUS AND NON-FERROUS METALS

Taming over 7 Trillion Gallons of Turbulent Missouri River

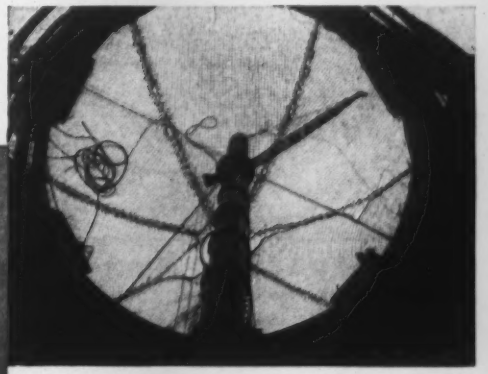


CB&I Surge Tanks serve Garrison Dam

When completed, the new Garrison Dam, opened in January 1956 near Riverdale, North Dakota, will provide 400,000 kilowatts of power, provide flood control and needed irrigation for large areas of both North and South Dakota. Its huge reservoir will form a lake 200 miles long to hold 7,494,573,000,000 gallons of Missouri River water.

To control the turbulence of these waters as they race from reservoir to power tunnel, Army engineers of the Missouri River Division will rely on the six CB&I surge tanks shown above.

These 65 ft. diam. by 135 ft. high tanks are typical of pipelines, penstocks and steel plate structures CB&I has built for hydroelectric generating plants and for water diversion projects all over the world. Our plants are fully equipped and competently staffed to design, fabricate and *erect* such structures to *your* specifications. Write your nearest CB&I office for further details.



Worm's-eye view looking up through safety net to boom tower used during erection of CB&I surge tanks at Garrison Dam.

E-47

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HERE'S WHY THE ALL PURPOSE END SUCTION PUMP

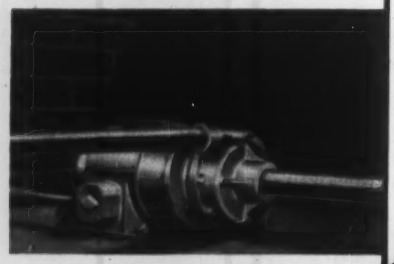
is more popular every day

AND WHY THE

PEERLESS *Fluidyne* LINE

TRADE MARK

IS ONE OF AMERICA'S MOST POPULAR BRANDS



ALL PURPOSE

Peerless Fluidyne pumps can be used for almost every general purpose pumping condition where *quality with economy* is a condition of pump application.

COMPACT

Space costs money; Fluidyne pumps fit neatly into both piping and pumping layouts as well as into sub-assemblies.

EASY TO MAINTAIN

No special tools are required to perform ordinary pump maintenance in the Peerless line.

ATTENTION-FREE

Ample safety factors assure performance on continuous or intermittent duty, regardless of mounting angle.

QUALITY FIRST

Every consideration has been given in design and construction to assure long service life even under abnormal conditions. Designed with economy in first cost, installation, maintenance and operation—all without compromise in quality.

HUNDREDS OF SIZES

The Peerless Fluidyne line is one of the broadest offered by any manufacturer. Drives: electric, belt or flexible coupled; HP range: from ¼ to 150 hp; Capacities: up to 5500 gpm; Heads: up to 260 ft.

QUICK AVAILABILITY

Peerless stocks its Fluidyne line at branch offices geographically located at major population centers. This stocking plus Indianapolis, Indiana and Los Angeles plants makes possible *quick* shipments of anything from a pump to a truckload.

NEW STYLING

Pleasing, trim and compact, their sturdy exterior design makes for neat installations.

OUTDOORS-INDOORS

Indoors or out, every general utility pumping service can use Peerless Fluidyne Pumps. In all sizes, types and models the Fluidyne line is characterized by high performance ratings.

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☐ *Please send me Peerless Pump Bulletin No. B-2300 describing Fluidyne line of fractional and integral hp pumps.*

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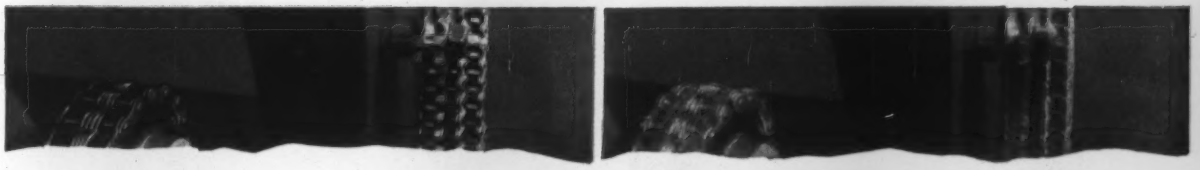
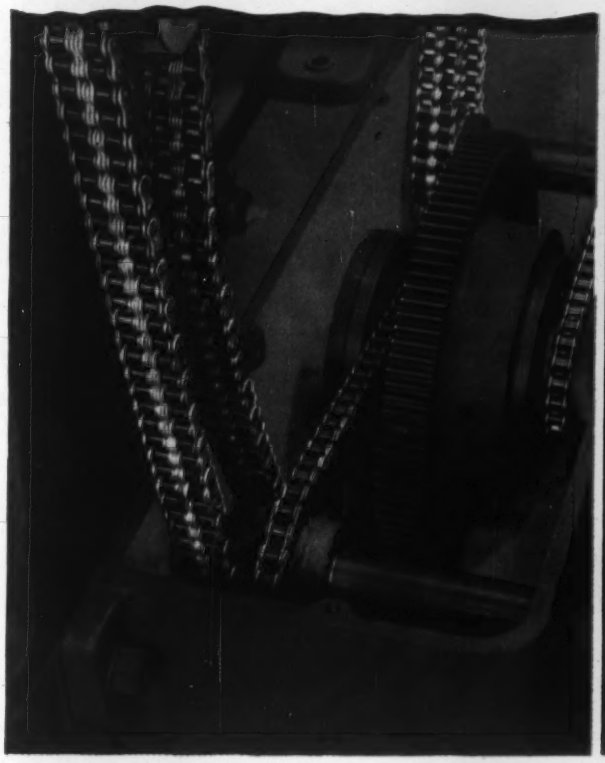


To static strength . . . add *dynamic strength*



RESISTANCE TO TENSILE STRESS is achieved with properly heat-treated, accurately machined side bars made of premium steel and fitted with properly hardened pins, bushings, rollers.

STRENGTH OF CHAIN IN MOTION results from such refinements as pitch-hole preparation, micro-finish of parts, special processing of side bars, pre-lubrication, rigid quality control.

Why LINK-BELT roller chain takes stresses in stride

ON *tough-service* drives and conveyors, Link-Belt precision steel roller chain consistently delivers longer life. That's because its *greater dynamic strength* withstands the starting shock and centrifugal loads of severe operation.

Reports from users prove the effectiveness of Link-Belt's manufacturing extras that add to greater dynamic strength. Shot-peened rollers give greater fatigue life and ability to withstand impact . . . lock-type bushings end a common cause of chain stiffness . . . pre-stressing provides uniform load distribution . . . closer heat-treat control insures uniformity.

For facts, see your nearby Link-Belt office or authorized stock-carrying distributor. 14.643

LINK-BELT

ROLLER CHAIN AND SPROCKETS

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J. G. ZIEGLER, Pacific Coast Sales Engineer, a member of the Taylor Team of Instrumentation Scientists, is known internationally in his field. Together, the well-known team of Ziegler and Nichols have collaborated on such published papers as "Optimum Setting for Automatic Controllers," "Industrial Process Control," "Dynamic Accuracy in Temperature Measurement," "Valve Characteristics and Process Control," and many others.

N. B. NICHOLS, Chief Engineer, Taylor Instrument Companies, also has an international reputation as an instrumentation scientist. He was called to MIT during the war to work in the servomechanisms laboratory and later as group leader of the fire control division of the radiation laboratory. He edited a book on servomechanisms, and along with John Ziegler has authored a number of papers on the science of process control.

Bring your problems to these top

GEORGE E. HOWARD, Manager of the important Application Engineering Department of Taylor Instrument Companies, has had over 20 years experience in the design and application of engineered control systems, specializing in the Chemical, Petroleum and Textile Industries. During World War II Mr. Howard trained Government personnel on instrument operation and maintenance at the Government's Oak Ridge Atomic Energy Plant where Taylor was the prime contractor on instrumentation.

RICHARD N. POND, Vice President of the Instrument Society of America and a member of the Executive Board, has served the society in a variety of capacities since he first became active in the St. Louis chapter in 1946. He was secretary, and later chairman, of the committee on Instrumentation for Production Processing. He is a Divisional Sales Manager for his company, specializing in Oil Refining, Petrochemicals, Brewing, Power, Rubber and Plastics.

WE'RE FIELDING our first team at the ISA Show in Cleveland. There will be 27 top Taylormen there—the 4 shown and 23 listed below. We're proud of the ability and experience of this team.

They'll be there—with headquarters at Booth 949-955—to put their skills to work on your own specific instrumentation problems. These men, drawn from our application engineering and sales departments, take to the show broad backgrounds of successful experience in the solution of instrumentation problems throughout the processing industries. They will be there only because you are going, too—so, why not stop by and put them to work on your plant's problems?

These men are typical of the world-wide Taylor sales and engineering organization that stands ready to help you with your instrumentation problems. Taylor Instrument Companies, Rochester 1, N.Y., and Toronto, Canada.

Taylormen at the ISA Show!

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Shaft Location Under High Radial Loads with Cylindrical Roller Bearings . . .

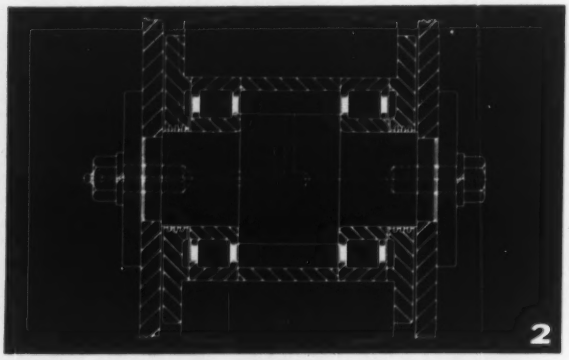
HYATT provides a variety of shouldered-race types to assure dependable shaft restraint in one or both directions . . . plus maximum radial load capacity

Cylindrical roller bearings have long been recognized by design engineers for their unequaled ability to sustain heavy radial loads. Since the primary movement of wheels, shafts or gears with respect to stationary housings in all types of machinery is *rotational*, the basic design of cylindrical roller bearings is relatively simple, and at the same time excellent for: a) Supporting heavy radial loads, and b) Positioning moving parts accurately with respect to their axes.

Less well recognized, however, is the ability of properly-built cylindrical roller bearings to perform most efficiently a third function frequently required of bearings: c) Locating moving parts laterally.

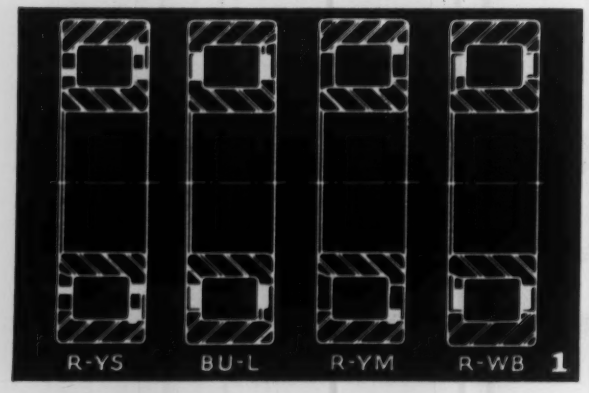
1. CHOICE OF BEARING TYPES

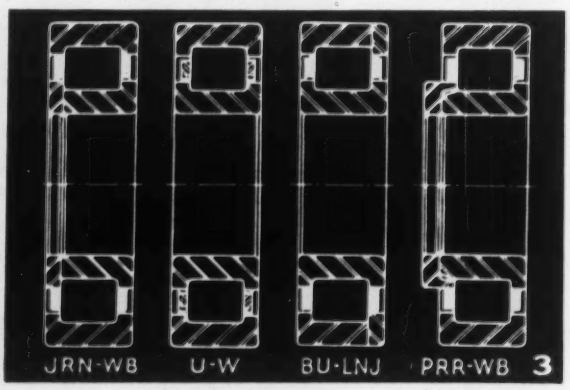
The design may require parts to be restrained laterally in one direction only, or in both directions, and this definitely determines the selection of bearings. Here the designer has a choice of types, depending on whether the machine elements favor one or two shouldered-race bearings. Whether inner or outer races are shouldered or whether assemblies are separable or non-separable has no effect on the ability of the bearing to perform its primary functions of supporting radial loads and positioning parts axially.

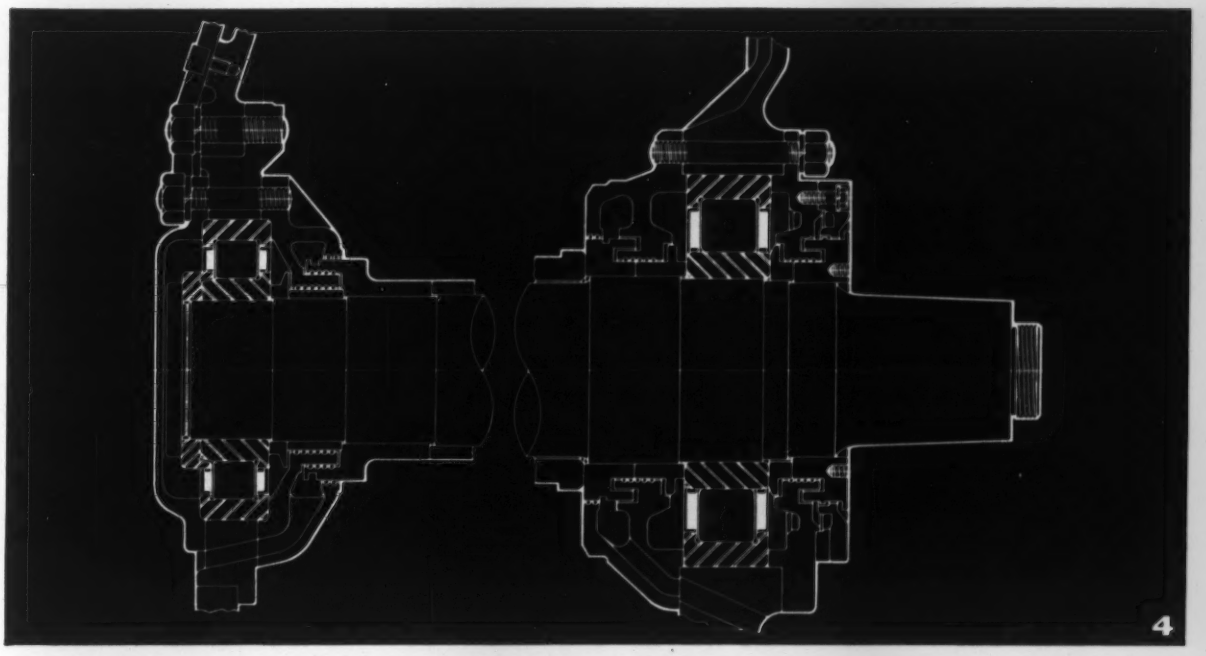


2. ONE-DIRECTION LOCATING BEARINGS

In most applications shaft location is accomplished by two opposing shouldered-race bearings, one restraining shaft movement in one direction and the other in the opposite direction. Depending on the conditions present, the designer has a choice of HYATT HY-ROLL types R-YS, BU-L,





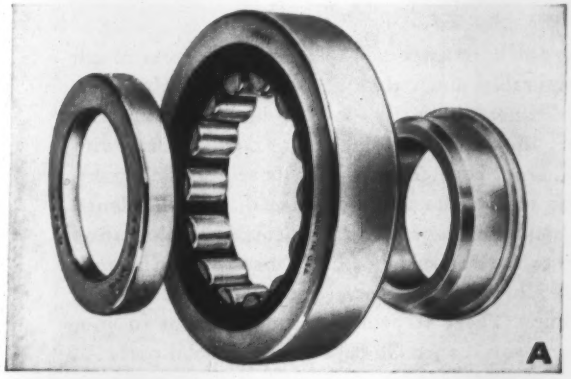


Diesel locomotive traction motor armature shaft with HYATT type PRR-WB at commutator end, type A-W B at pinion end.

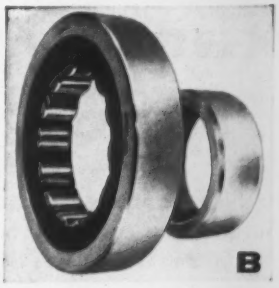
R-YM, R-WB (Fig. 1). Type RW-B, for example, has conclusively proved its shaft-locating dependability in heavy-duty service such as the armature shafts of steel mill motors and elevator cable sheaves. All four types are normally mounted in opposing pairs (Fig. 2). Sufficient end clearance is usually provided in the assembly to prevent binding in operation, particularly if temperature conditions cause the shaft to expand laterally.

3. TWO-DIRECTION LOCATING BEARINGS

Where the application indicates the use of only one bearing to locate a moving part in both directions, the designer may choose from HYATT Hy-Roll types JRN-WB, BU-LNJ and PRR-WB—or for relatively light loads, type U-W (Fig. 3). An outstanding heavy-duty application of type PRR-WB, for instance, is on the commutator end of diesel locomotive traction motor armature shafts. Used in this manner, the commutator end bearing relieves the pinion end bearing of all thrust forces, thus permitting it to function most effectively in supporting the heavy radial loads transmitted by the drive pinion. Type PRR-WB has a long record of excellent performance in this punishing service (Fig. 4 and Photo A).



4. PROVISION FOR SHAFT EXPANSION



Another advantage of using a HYATT bearing capable of locating the shaft in both directions is that it permits the shaft to expand laterally. When a HYATT type A-WB with straight cylindrical inner race, for example, is mounted on the other end of the shaft (Fig. 4 and Photo B), the shaft can expand laterally through it without binding the locating bearing.

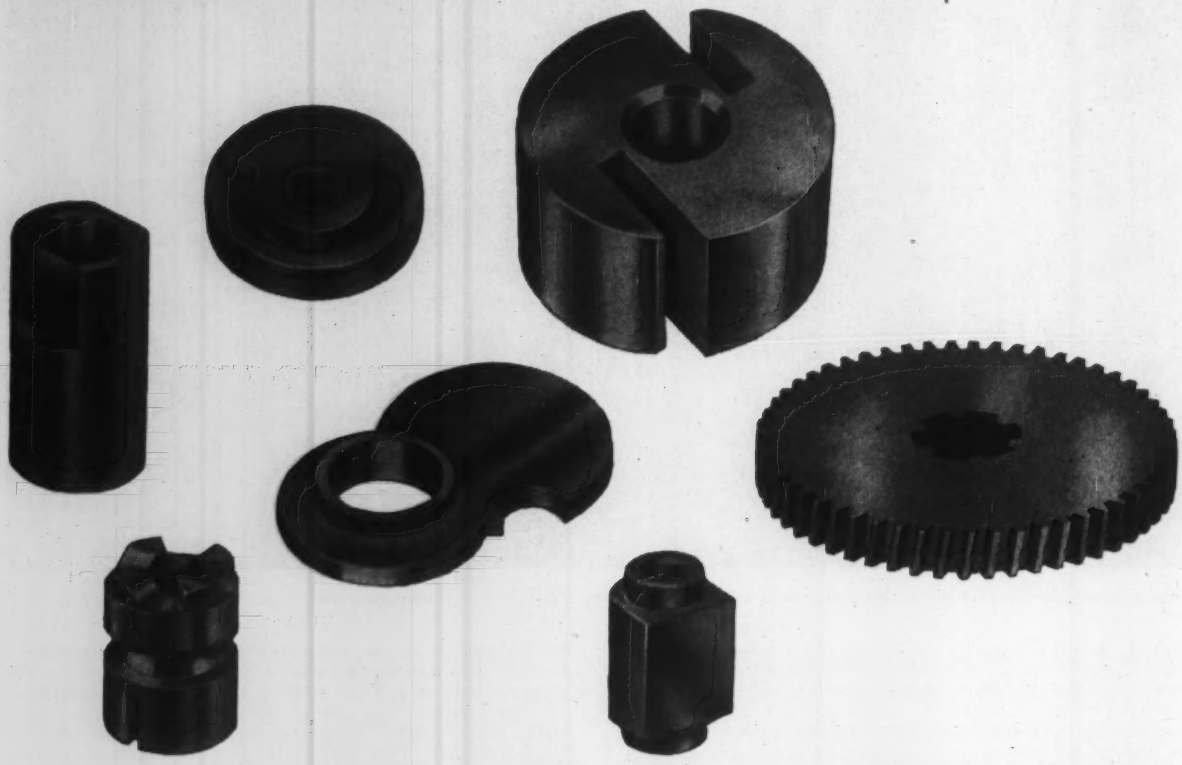
To assure the simplest, most economical and dependable shaft location in one or both directions *without sacrifice of radial load-carrying capacity*, always specify HYATT Hy-Roll Roller Bearings. They will more than measure up to your requirements.

You will find full selection and application data in HYATT Catalog 150, or call your nearest HYATT Sales Engineer for expert assistance. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.; Pittsburgh; Detroit; Chicago; Oakland, California.

HYATT HY-ROLL BEARINGS FOR MODERN INDUSTRY

GM GENERAL MOTORS

regardless of SHAPE...



economical GRAMIX®

(PRODUCTS OF POWDER METALLURGY)

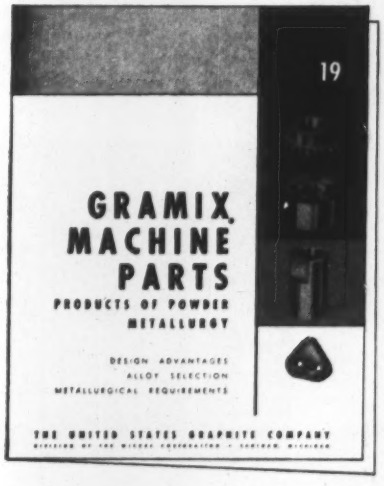
in the exact form to meet your ...ready to install!

Were you to machine the above parts from bar stock, or were you to finish them from rough castings or forgings, the cost would be considerable, due to their complex shapes. However, these parts—and thousands of others of comparable complexity—are produced economically by the GRAMIX process. GRAMIX parts are die-pressed to the exact shape desired, with tolerances as close as .0005", then sintered. Further machining is seldom necessary, though we often perform a coining operation to give the part a burnished, work-hardened surface. GRAMIX parts can be impregnated with various high-grade oils to furnish self-lubrication at wear surfaces. Alloys available include an extensive variety of brass, bronze, and ferrous types, and our manufacturing process allows us to accurately control the density of GRAMIX parts, assuring a uniform structure. There is probably a component in your product that could be improved with GRAMIX sintered metal parts . . . Have you given it consideration?

THE UNITED STATES

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® SINTERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

machine parts can be made design requirements . . .



ENGINEERING BULLETIN No. 19

Product engineers specifying materials will find a wealth of design information in this GRAMIX Machine Parts Bulletin. This material is presented in such concise form that questions are quickly and easily answered. A simple chart indicates which alloys—ferrous and non-ferrous—are suitable for different operating requirements. Working sketches show the various design possibilities—radii, helical teeth, dead-end holes, flanges, multiple shoulders—and how they can be utilized to best advantage. Physical properties are presented, and metallography discussed. In all, you'll find Bulletin 19 an ideally simplified guide to a complex subject . . . write now for your copy. 118

GRAPHITE COMPANY

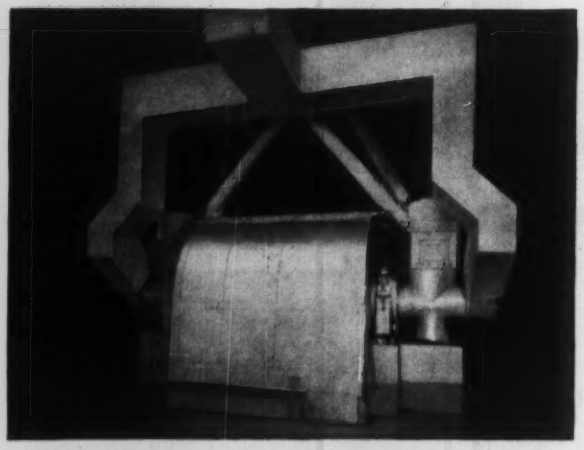
DIVISION OF THE WICKES CORPORATION, SAGINAW 4, MICHIGAN

HEAT ENGINEERING by FW

for MAJOR STEAM GENERATING and

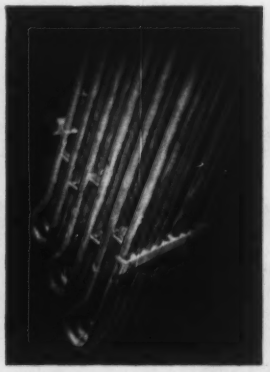
STEAM generator design and heat engineering are virtually synonymous. The problem is basically one of generating heat and transferring it to water and water vapor to produce a dependable and abundant source of steam at the desired temperature and pressure. To do this most efficiently and economically calls for heat engineering of the highest order.

With over 50 years of world-wide experience in this specialized field, Foster Wheeler is exceptionally well equipped to meet the most exacting requirements of the modern, high pressure steam generating plant. Starting with the commercial introduction of superheated steam in the United States in 1902, Foster Wheeler has pioneered and developed many major advances in steam generator design, including convection and radiant superheaters, air preheaters, high-pressure economizers, twin furnace construction, dual circulation and improved drum internals for high steam purity. And heat engineering by Foster Wheeler is continually researching and exploring new concepts of design to anticipate the needs and solve the problems of steam generating plants of the future. For information on equipment to meet your specific requirements, write to *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*



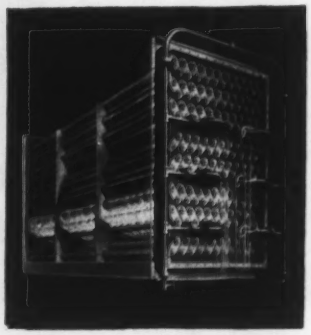
PULVERIZED FUEL was first developed on a commercially successful scale by Foster Wheeler in 1898. Today, FW ball mill pulverized fuel systems have a total installed capacity of more than 12 million pounds of coal per hour. The FW ball mill offers the proved advantages of constant fineness, high availability, large reserve capacity and ability to handle hard and abrasive fuels.

The new planetary roll and table pulverizer, introduced in 1956, supplements the FW line with a compact and highly efficient unit that is very economical and easy to maintain.



SUPERHEATERS of the convection and radiant type, used singly or in combination, provide constant superheat and accurate control of final temperature over a wide load range. The first radiant superheater was installed by FW in 1917 and since that time, approximately one thousand units have been put in service.

ECONOMIZERS. The extended surface, cast-iron-covered economizer, developed by Foster Wheeler, assures maximum heat transfer from boiler exit gases to boiler feedwater. The FW design has proved to be highly corrosion resistant, impervious to soot fires and easily cleaned.

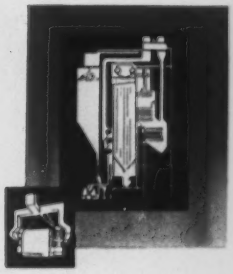


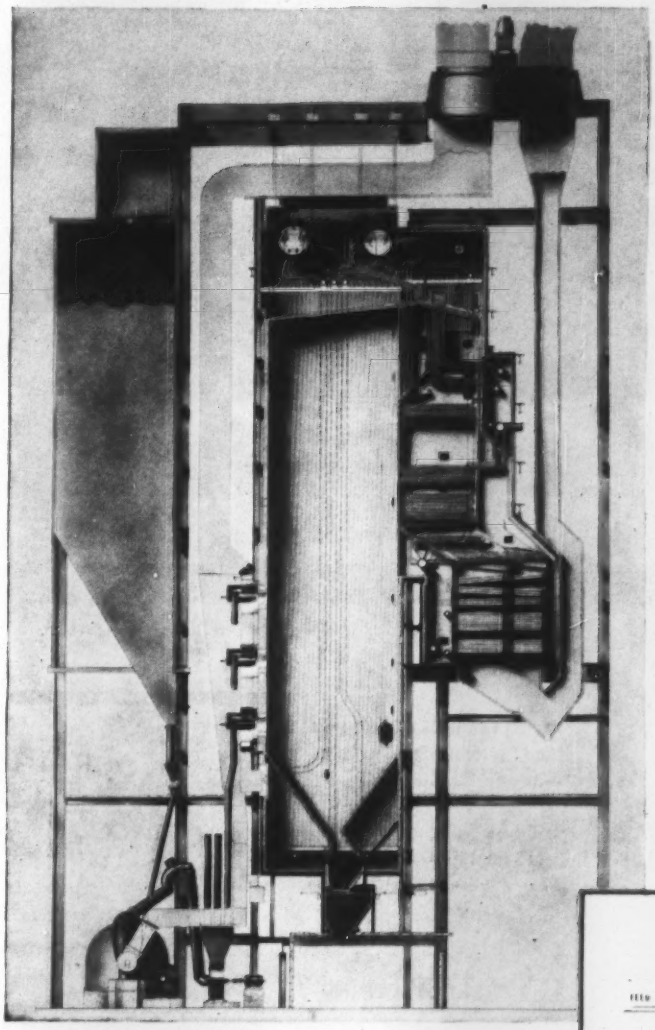
FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

sets the highest standards

PULVERIZING EQUIPMENT



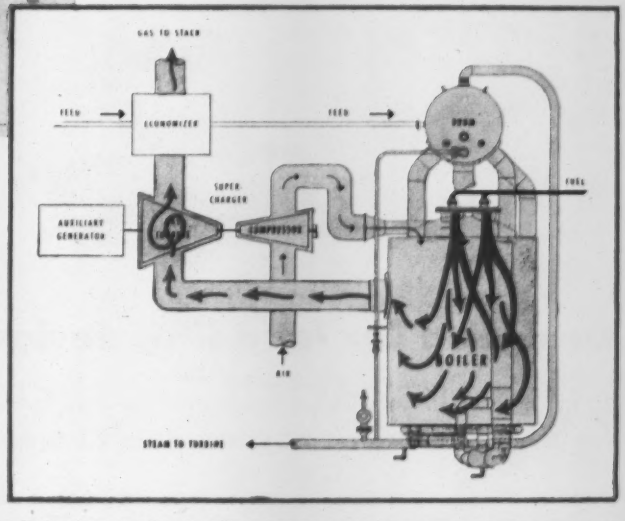


DUAL CIRCULATION was introduced by Foster Wheeler in 1946, providing the first practical solution to the problem of providing high purity steam at pressures above 600 psi from feedwater containing relatively high silica. This is achieved by dividing the steam generator into two separate sections — a high heat absorption primary and a low heat absorption secondary section. Blowdown from the primary is fed into the secondary section, from which steam is delivered to the separating equipment and condensed by incoming feedwater. Hence the primary section, where virtually all of the output steam is generated, is maintained at a very low concentration of impurities. This sharply reduces silica carryover and total dissolved solids in the steam

REHEAT. The reheat cycle, also pioneered by Foster Wheeler, has resulted in important fuel savings and increased operating efficiency for large central station and industrial steam generators. The list of major FW reheat projects includes a unit capable of producing 2,000,000 lb/hr to serve a 300,000 kw turbine generator.

This Foster Wheeler unit, placed in operation in 1955, is the first **dual circulation, reheat** steam generator ever built with a capacity of more than 1,000,000 lb/hr

THE SUPERCHARGED BOILER is a revolutionary new development, announced by Foster Wheeler in 1956 and still under investigation and test. It offers the advantages of high overall economy, drastic reduction in size and weight, short startup time, quick load response and shop-assembled construction. High pressure discharge gases from the furnace are used to drive the combustion air compressor and an auxiliary generator which can supply up to 15% of total plant output. Further details are available on request.



...more quality proved POWELL VALVES

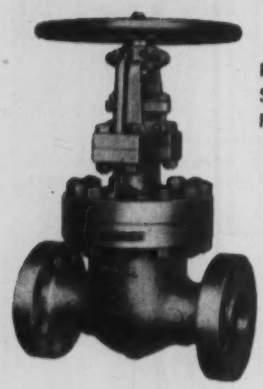


FIG. 1303 SS—1500-Pound Stainless Steel Gate Valve for handling Boiler Feed Water Treating Compound.

FIG. 3061 WE—300-Pound Steel Swing Check Valve.

FIG. 1314 A—1500-Pound Integral Bonnet Steel "Y" Valve.

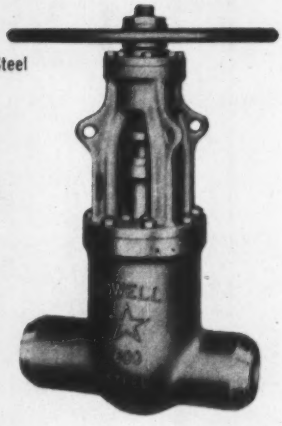
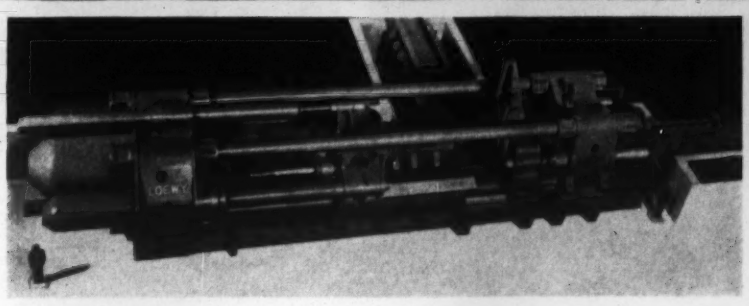


FIG. 16003 WE—600-Pound Steel Pressure Seal Gate Valve.

Designed for long life, designed for dependable service

Consult your Powell Valve distributor for all the facts about quality proved bronze, iron, steel and corrosion-resistant valves. No matter what the flow control problem, a Powell Valve can solve it . . . *better.*

THE WM. POWELL COMPANY, CINCINNATI 22, OHIO . . . 111th YEAR



12,000-ton extrusion press designed and built by Loewy-Hydropress for the U.S. Air Force Heavy Press Program and operated by the Metals Processing Division of Curtiss-Wright Corporation, Buffalo, N.Y.

●

Scale model of 12,000-ton extrusion press showing its enormous length. It was used for training the erection crew.

World's largest steel and titanium extrusion press squeezes out tube 50 ft. long, of 6-in. diameter, in 9 seconds

Designed and built by Loewy-Hydropress for the U.S. Air Force Heavy Press Program, this huge hydraulic machine is able to turn out in production quantities the largest steel and titanium extrusions ever made. Installed at the Curtiss-Wright plant in Buffalo, it can produce a 50-ft. steel tube of 6-in. diameter in 9 seconds, or 1000 ft. of ½ in. spring steel rod in 3 seconds. The speed and method of operation of this press result in remarkably reduced costs for both the Air Force and industry.

Because of the severe demands imposed upon a machine doing such work, this press offers convincing evidence that Loewy-Hydropress is first in steel extrusion.

If you need extrusion presses, forging presses, rolling mills, or auxiliary equipment of *any* capacity, call on Loewy-Hydropress. The same engineering skills that produced this 12,000-ton-capacity machine will go to work in your service, no matter how large or small the equipment you need. Write us today, Dept. F-9, for more information.

Loewy-Hydropress Division

BALDWIN · LIMA · HAMILTON

111 FIFTH AVENUE, NEW YORK 3, N.Y. Rolling mills • Hydraulic machinery • Industrial engineering

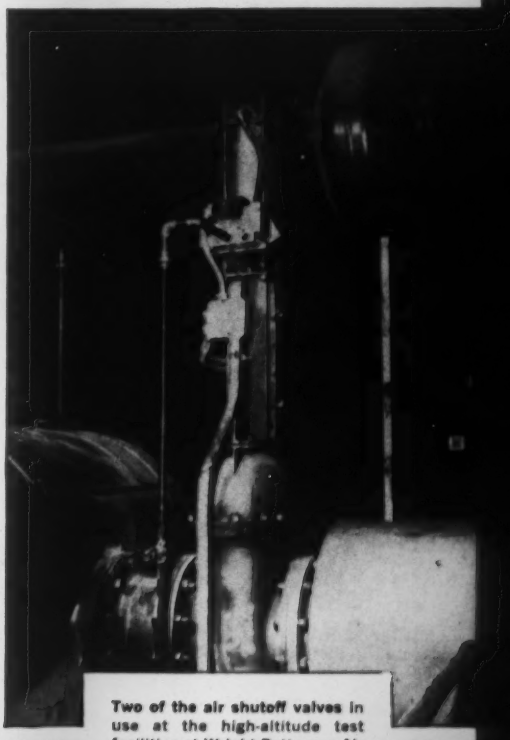
Low-temperature air shutoff valves

To quote J. L. Williams, Vice-President and General Manager of Fabri Valve, "We chose USS 'T-1' Steel for its toughness, impact strength, its quality of handling low temperature applications. Moreover, advantage could be taken of the minimum yield strength of 90,000 psi in reducing thickness, thereby reducing cost."

S. L. Kum, Chief Engineer, inspects an air shutoff valve. "USS 'T-1' Steel is what we needed in this job. It has all the qualities that this low temperature application calls for. And the weldability of USS 'T-1' Steel meant a great deal to us in cutting costs and time in constructing the valves."

fabricated from USS "T-1" Steel

...faster ...stronger ...at lower cost!



Two of the air shutoff valves in use at the high-altitude test facilities at Wright-Patterson Air Force Base, Dayton, Ohio.

THE FABRI VALVE COMPANY of America, in Portland, Oregon, recently used USS "T-1" Steel for the construction of two special types of valves for a U.S. Air Force high-altitude test facility.

The valves—two 12-inch and one 16-inch—are electric-motor-operated wedge-gate valves. They are subject to temperatures from well below 0°F. to +300°F., and pressures of 37.5 psi absolute plus a shock load of 200 psi gage. USS "T-1" Steel was used to fabricate the body, chest and bonnet, body flanges, chest and bonnet flanges, gate assembly, packing gland, and yoke.

Here are the steps followed in fabricating these valves:

1. **USS "T-1" Steel plates go to boiler shop for bending and shearing.**
2. **If a raised face is called for, it is welded on.**
3. **Parts go to shop for intermediate machining.**
4. **Parts returned to boiler shop for partial assembly and finished welding.**
5. **Sandblasting.**
6. **Valves (partially assembled) go to shop for final machining and assembly.**
7. **Valves tested and inspected to insure conformity with specifications and capability of performing job required.**

Fabri Valve Company officials estimated that by using USS "T-1" Steel, the entire job of constructing the special valves was trimmed by approximately 25 per cent. USS "T-1" Steel's unique combination of properties—fabricability with high yield and ultimate strengths, extraordinary toughness at high and low temperatures, and impact-abrasion resistance—mark it as just the steel to improve *your* product while cutting your costs. For more information, write United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

United States Steel Corporation, Pittsburgh
Columbia-Geneva Steel Division, San Francisco · Tennessee Coal & Iron Division, Fairfield Ala.
United States Steel Supply Division, Warehouse Distributors
United States Steel Export Company, New York

USS "T-1" CONSTRUCTIONAL ALLOY STEEL

USS

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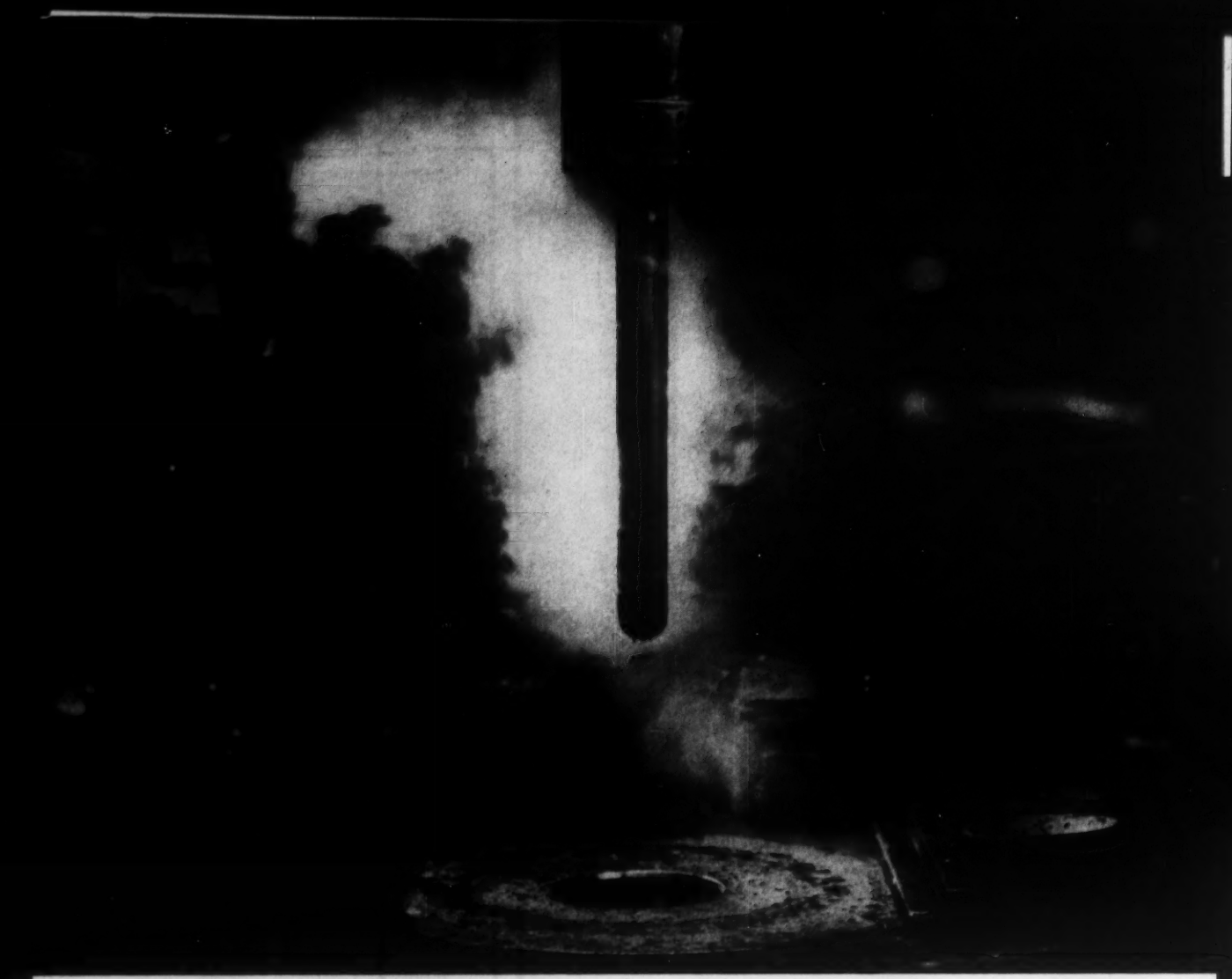
UNITED STATES STEEL



Tough 2½" diameter mandrel at Rc 44 on 1150 ton brass extrusion press. Scovill Manufacturing Co.

Mandrel of HALCOMB 218 retains toughness and hardness at hot work temperatures...

This mandrel is made of Halcomb 218—a tough, air-hardening hot work steel. Halcomb 218 is suitable for tools like this which require a higher degree of toughness at moderately elevated temperatures than is obtainable with the tungsten types of hot work steels. And Halcomb 218 *retains both* its hardness and strength at these temperatures.

For example, at a hardness of Rc 44, Halcomb 218's Charpy Impact Strength is 33 ft-lbs at 500F. And it will retain this hardness after 1 hour, after 10 hours and even after 100 hours at temperatures up to 900F.

Properties like these cut tooling costs. The mandrel shown above is good for 1200 pushes, for example, and even then all it needs, usually, is repolishing before being used again.

Halcomb 218 is particularly useful for all hot work operations on which drastic coolants are used. It even resists breaking very successfully when water cooled in operation. If these sound like advantages you can use, call your local Crucible representative for more complete data. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

Canadian Distributor—Railway & Power Engineering Corp., Ltd.

Completely Oil-Sealed!

A-B QUALITY

SEALED HEAD KEEPS OUT OIL, COOLANT, METAL CHIPS ...your guarantee of reliable limit switch operation!

With *completely sealed* operating heads, as well as sealed switch bodies, Allen-Bradley Bulletin 802T oiltight limit switches provide maximum reliability in limit switch operation for your modern, high speed production machines. The sealed head excludes oil, dirt, and metal chips from the operating mechanism ... the spring return, momentary contact operators cannot become sluggish and stick.

The maintenance free, double break, silver alloy contacts are sealed in the oiltight body. Interchangeable operating heads are available with various push rods and levers which can be mounted in any one of four positions. Oiltight transparent plastic covers, for inspecting contacts and wiring without removing the cover, are available for most units.

Here's a line of *quality* limit switches in which each type will provide millions of trouble free operations. Have your A-B control engineer acquaint you with this latest development—another advance in limit switch design.

802TC Side Push Rod Type

802TF Rod Type

802TA Roller Lever Type

802TB Top Push Rod Type with Plastic Window

802TAO Roller Lever Type for Cavity Mounting

802TG Adjustable Roller Lever Type

ALLEN-BRADLEY
MOTOR CONTROL
QUALITY

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

9-57-MR

NOW... ALLEN-BRADLEY PRECISION-TYPE LIMIT SWITCHES ARE ALSO OILTIGHT!

OILTIGHT HEAD — Newly designed head on push type seals out oil. Roller lever types have sealed operating shafts.

OILTIGHT BODY — Synthetic rubber gasket between housing and plate excludes oil and coolant from operating mechanism.

Allen-Bradley precision-type limit switches combine very close operating tolerances with such a sturdy construction that they can be used for any industrial application. Now this line of limit switches has been further improved by making them completely oiltight.

Especially designed for use where the motion to operate the limit switch is measured in thousandths of an inch, these Allen-Bradley limit switches can henceforth be employed in applications where oils, coolants, and dust are present.

Allen-Bradley Bulletin 802 oiltight precision limit switches have a positive snap action mechanism which prevents any possibility of a "dead center" . . . no matter how slowly the actuating force is applied. They are available in both the spring return and maintained contact construction. And all have maintenance free, double break, silver alloy contacts.

Specify these Allen-Bradley oiltight limit switches where "precision" operation is required and where dirt and oil could cause trouble.

Push rod type. Plastic cover, for inspection without removing cover, made for most units.

Roller lever type limit switch with lever on right side. Also available with lever on left side.

Roller lever precision-type limit switch with roller lever in front of the switch body.

ALSO—GENERAL PURPOSE LIMIT SWITCHES

Bulletin 801 general purpose limit switches in standard or heavy duty ratings. Maintained or momentary contacts with slow or snap action. Silver alloy contacts used throughout this line.

9-57-MR

MR. ENGINEER:

LET'S FACE THE FACTS . . .

How can an underground piping system be watertight when you can't *AIR TEST* it?

Test caps applied to unit ends for air testing full-welded conduit system.

During air test, conduit field welds are checked with soap solution.

WITH

RIC-WIL

Tested and ready for lowering long lengths.

YOU can AIR TEST your system...

The RIC-WIL method of making full-welded field closures allows the installer to AIR TEST the system prior to completion and backfilling. This simple 15 lb. pressure test gives greater assurance of a tight, leak-proof system. It provides the finest practicable protection to the owner against an initial system failure ...and most important, the long range effects of water corrosion.

Ask a RIC-WIL field representative for detailed information regarding Air Test procedure or write for catalog covering recommended field installation details . . . and remember, it pays to do it RIGHT the first time . . .

Quality Piping Systems . . .
. . . of Exceptionally High Thermal Efficiency
SINCE 1910

RIC-WIL INCORPORATED — PREFABRICATED INSULATED PIPING SYSTEMS

BARBERTON, OHIO

IN CANADA: THE RIC-WIL COMPANY OF CANADA LIMITED

. . . Fluid Power news

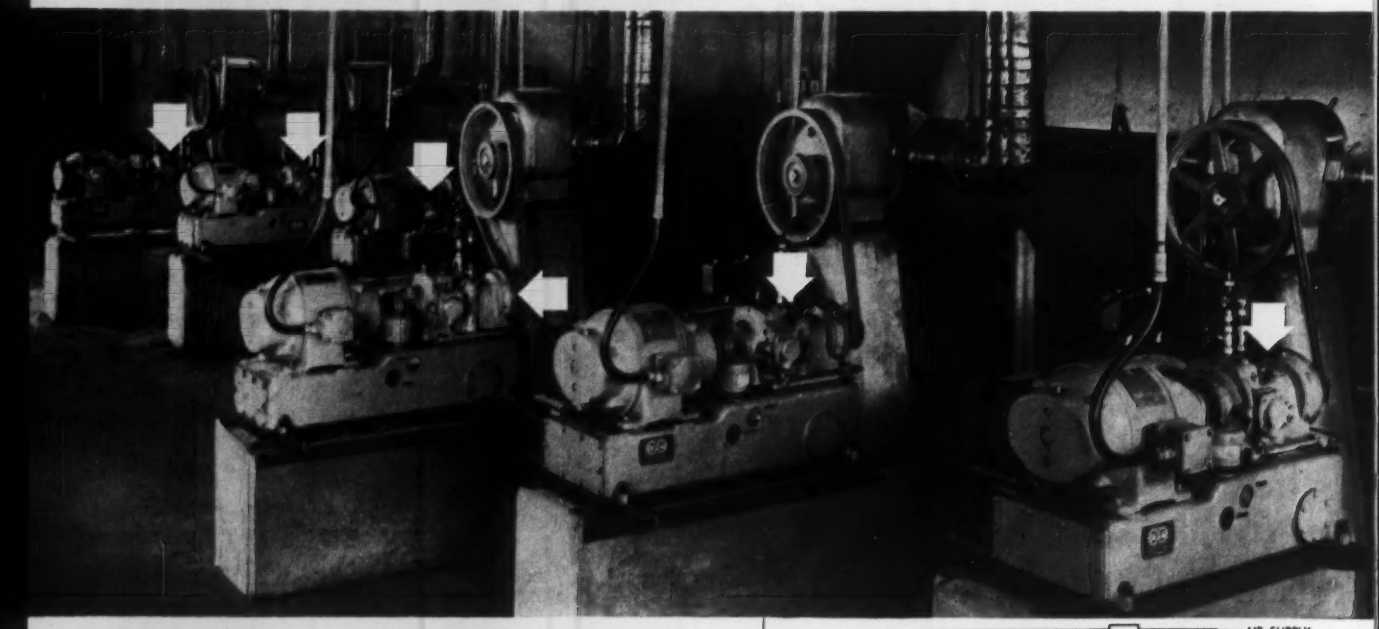
REPORT NO. 11,300 NEW LIQUID LEVEL CONTROL

From Oilgear Application-Engineering Files

HOW OILGEAR DRIVE AND CONTROL SYSTEM STABILIZED BEER FILLING LEVEL

CUSTOMER: *Large Western Brewery (Name witheld by request)*

DATA: Highly carbonated beverages must be handled gently. Throttling flow of beer into filling machine reservoirs causes foam and irregularity of liquid height, making accurate filling of cans or bottles difficult. These reservoirs are small compared to the flow through them. Costly losses are incurred on tax-paid cans "in process" due to under or overfilling. Any beer pump drive-control system must respond immediately, have smooth action, and be unaffected by daily washdowns required to maintain sanitary operations. Accurate automatic control, dependable operation, and ease of maintenance—as always—are important factors in the selection of this equipment.



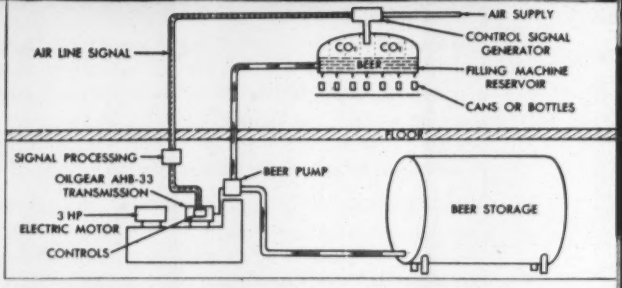
SOLUTION: Shown "on the job" above, are 6 Oilgear AHB-33, two-way, "Any-Speed" transmissions driven by 3 hp electric motors, mounted on standard reservoir bases. Transmissions drive beer pumps through dual "V" belts. Beer is pumped from storage tanks to bottle or can filling machine reservoirs on the floor above. Liquid level in filling reservoirs is controlled automatically by a low pressure CO_2 signal . . . as level rises, pressure rises . . . as level falls, pressure falls. Translated to air pressure signals, which, transmitted to controls on Oilgear transmissions, automatically-instantly increase, decrease, reverse, or stop the beer pumps. Where former throttling system caused foam and irregular levels, this Oilgear system holds reservoir level to $\pm 1/16$" under continuous operation . . . assuring accurate filling of each can or bottle. Beer pumps are flushed under water pressure without disconnecting drives. Several years of continuous service have proven drives to be extremely dependable under all conditions, with little or no attention.

Oilgear Application-Engineering can also provide practical solutions to your linear or rotary drive problems. Call the factory-trained Oilgear application-engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY

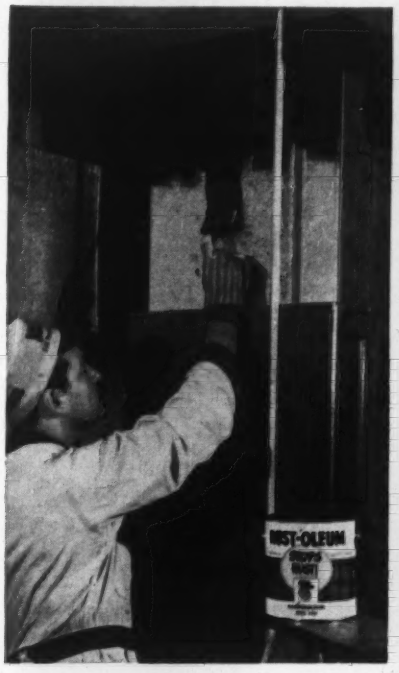
Application-Engineered Fluid Power Systems

1570 WEST PIERCE STREET • MILWAUKEE 4, WISCONSIN



Similar Oilgear "Any-Speed" drives have improved performance on can closing, filling; paper, printing, textile, tape, and rubber processing machines; extruders, capstans, winders, stokers, centrifuges, gang-saw feeds, saw mill carriages, conveyors, and the like. They provide efficient conversion of any constant rotary motion to accurately controlled variable rotary motion . . . smooth, stepless, uniform acceleration from zero to maximum in either direction . . . manual, hydraulic, electric or electro-hydraulic controls—providing complete flexibility of location . . . low power consumption—using power only in proportion to work performed . . . durable, trouble-free, low maintenance due to simplicity and automatic lubrication of all rotating parts.

A coating in COLORS that really sticks to new Galvanized, Aluminum and Terne Plate



RUST-OLEUM®
GALVINOLEUM® COATINGS

Remember? If you didn't go over every square inch of new galvanized metal with a chemical solution before painting . . . chances are that the paint "peeled off" leaving you with a costly eye-sore!

The development of Galvinoleum Coatings by Rust-Oleum changes all this! *Now* . . . you simply brush Galvinoleum right over brand new or unpainted Galvanized, Aluminum, or Terne Plate . . . no etching . . . no weathering . . . and it *lasts and lasts!* No "peeling" worries, no costly "headaches" . . . you have your choice of Red, Gray, Green, and Metallic! And you can use Rust-Oleum 575 Outside White, or any high-quality oil base house paint, over the Galvinoleum to match trim.

Pioneered, developed and field-tested by the Rust-Oleum Corporation — you have the assurance of a *brand name* backed by over thirty-five years of proved performance throughout industry. Try Galvinoleum . . . write for your illustrated Galvinoleum booklet with color charts.

RUST-OLEUM®

STOPS RUST!®

Rust-Oleum, Galvinoleum, and Stops Rust are brand names and registered trademarks of the Rust-Oleum Corporation.

Prompt delivery from Industrial Distributor Stocks.

Rust-Oleum is distinctive as your own fingerprint. Accept no substitute.

ATTACH COUPON TO YOUR LETTERHEAD—MAIL TODAY!

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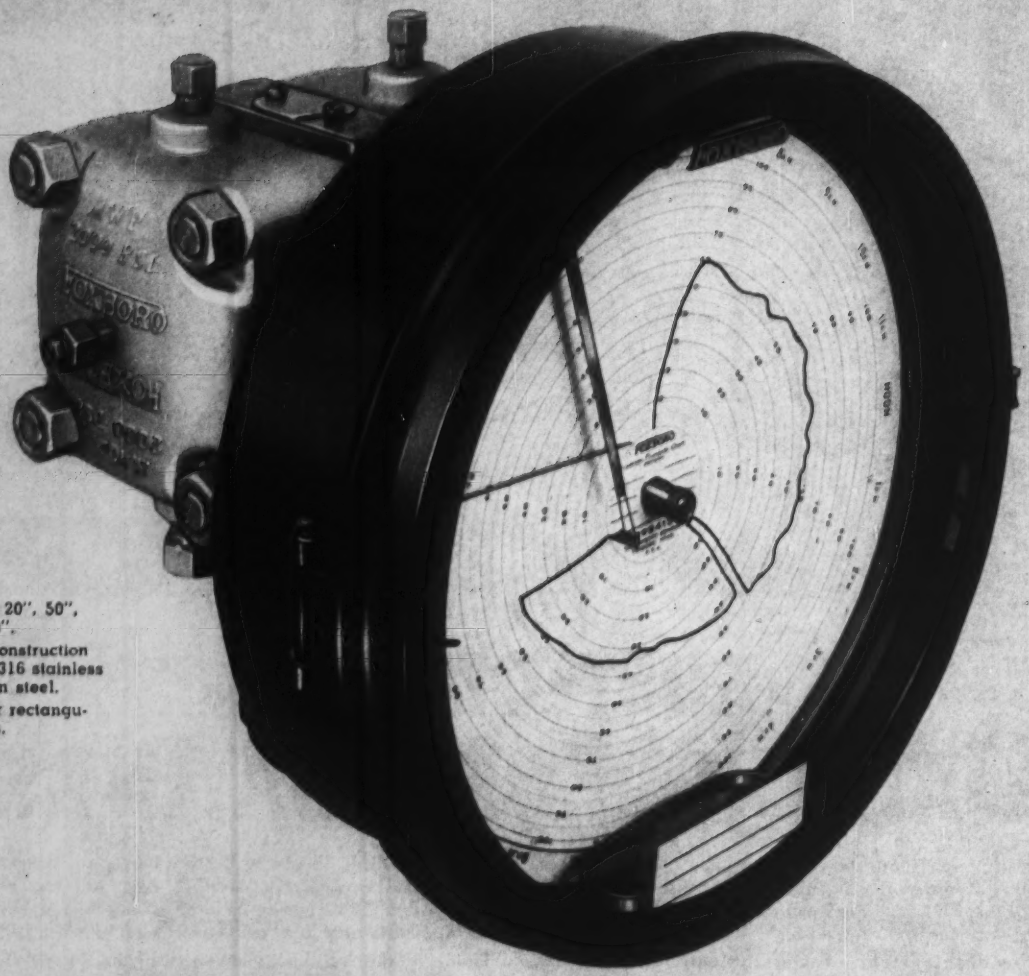
2515 Oakton Street • Evanston, Illinois

☐ Complete Rust-Oleum Galvinoleum Literature With Color Charts.

☐ Free Test Sample:
☐ Red ☐ Gray ☐ Green ☐ Metallic

☐ Nearest Source of Supply.

NOW... a "Dry" Flow Meter with .

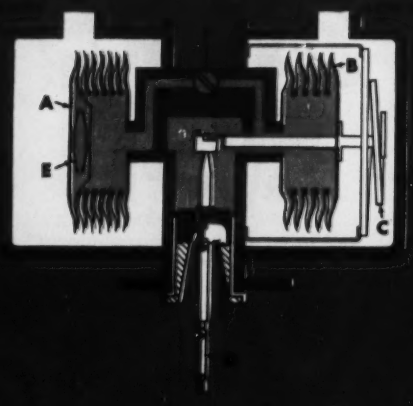


- Ranges: 20", 50", 100", 200".
- Forged construction in Type 316 stainless or carbon steel.
- Round or rectangular cases.

...the new Foxboro Type 37 Diaphragm Meter

How It Works

In schematic drawing at right, areas shown in color represent a stable, non-freezing liquid. Any pressure increase in the high pressure chamber compresses Diaphragm Unit A, displacing its liquid and expanding Diaphragm Unit B until force of Range Spring C equals the difference between the forces on Diaphragm Units A and B. Linear motion of Diaphragm Unit B moves inner end of Drive Bar D — outer end moves correspondingly through the bellows-sealed flexure bar, driving pen arm. Built-in Temperature Compensator (E) proportionately adjusts diaphragm capacity as ambient temperature variations affect volume of filling fluid. External damping adjustment is shown at F.



• complete overrange protection!

• sustained high accuracy!

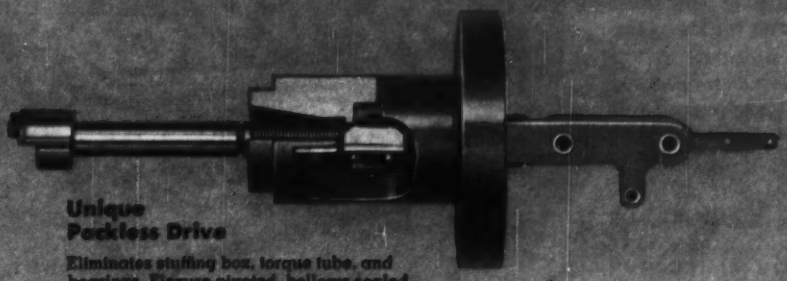
Now you can have mercuryless flow measurement for a wide range of differential pressures — at static pressures up to 2000 psi — with greater safety and dependability than ever before! The new Foxboro Type 37 Diaphragm Meter not only combines unmatched ruggedness and precision in a dry meter — it's by far the easiest to adjust and maintain. And it does away with zero drift problems, once and for all! Expansible, Type 316 S.S. diaphragm elements respond to changes in pressure with unmatched sensitivity, yet are completely immune to overrange up to full static pressure! A unique packless drive bar precisely transmits linear motion to the pen arm. Range-changing is easy, due to new twin-spiral spring design. Wide range damping is externally adjustable under pressure. And the Type 37 is self-compensating for temperature changes in all differential ranges. Get full details on this high utility, completely dependable dry flow meter. Arrange for a demonstration with your nearby Foxboro Field Engineer, or write

The Foxboro Company, 969 Neponset Ave., Foxboro, Mass., U.S.A.

FOXBORO

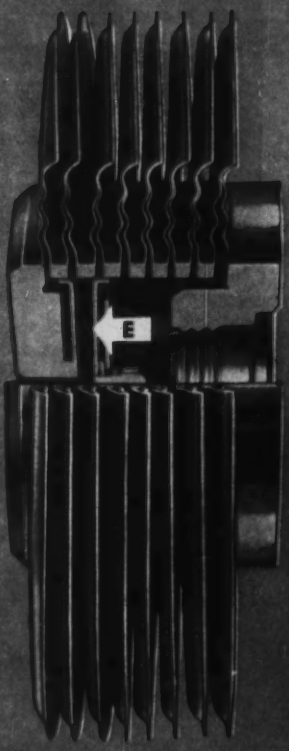
REG. U.S. PAT. OFF.

FIRST IN FLOW METERING



Unique Packless Drive

Eliminates stuffing box, torque tube, and bearings. Flexure-pivoted, bellows-sealed drive bar transmits diaphragm's linear motion to the pen arm with unequalled sensitivity and undiminished power. Seal for flexure pivot is a tough, flexible bellows.



Exclusive Diaphragm Elements

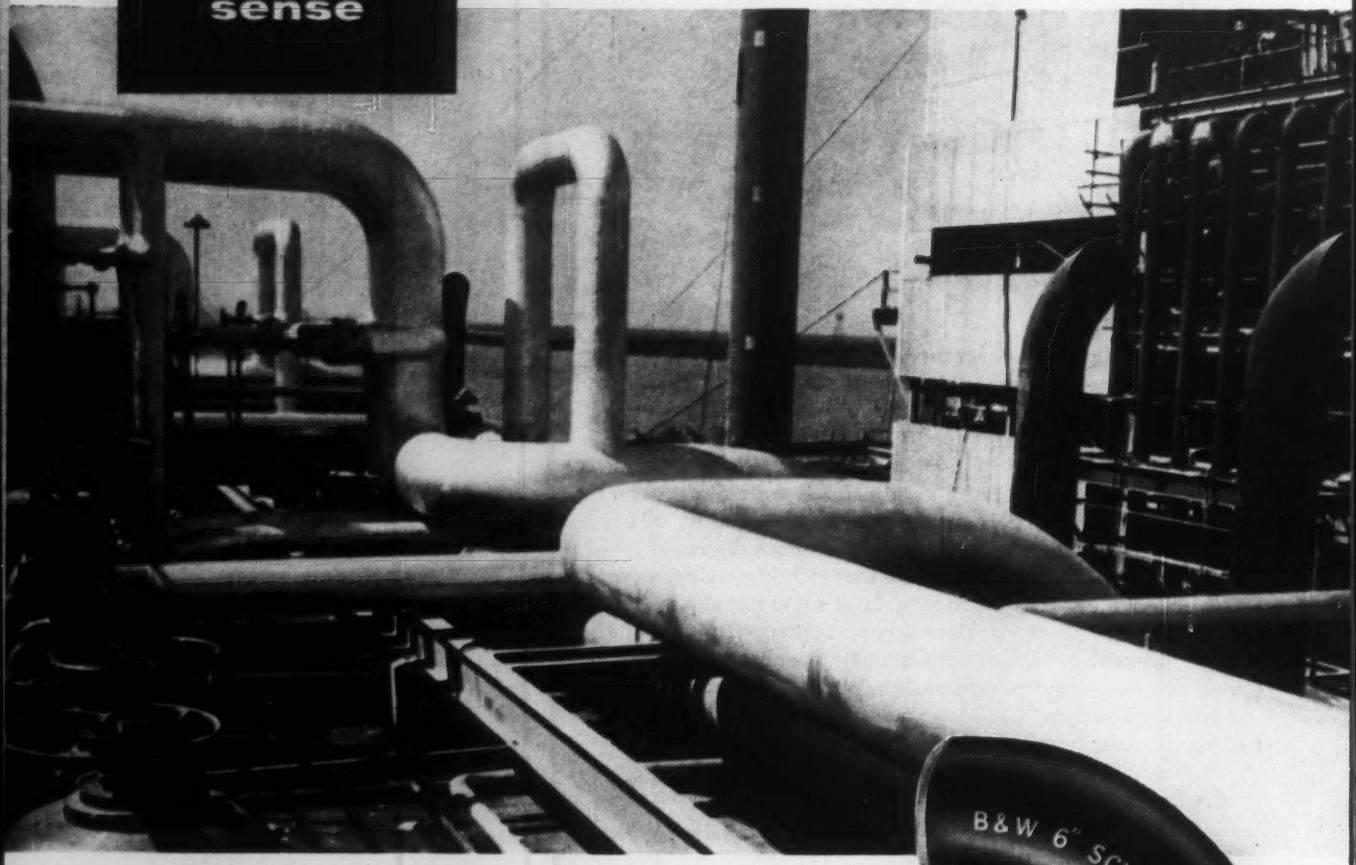
Type 316 S.S. diaphragm units in both high and low pressure chambers provide greatest linearity and freedom from hysteresis; nesting design and integral spacer rings provide safe, positive, overrange protection. Temperature compensation (E) is built into diaphragm assembly . . . never requires change or adjustment.

Exclusive Range Springs

Heavy gauge Ni-Span C alloy, twin-spiral springs provide high sensitivity with lasting accuracy. Readily accessible . . . range changes are easily made, in minutes!

result of an engineer's good common sense

insulation is easier and faster to apply when seamless welding fittings are used



THANKS to the engineer who specified B&W Seamless Welding Fittings, no humps or bumps had to be insulated here. Welding fittings became an actual part of this smooth, streamlined piping. And with a sound weld, welded connections are leakproof, pipelines are permanent. Insulation never has to be restored because of leaky joints. Therefore, maintenance is practically non-existent.

Seamless Welding Fittings combine strength with lightness-in-weight and allow closer nesting. B&W's dimensional accuracy such as full radius, true circularity and smooth walls of uniform thickness permits uninterrupted flow even under highest temperatures and pressures.

Be sure — and specify B&W Seamless Welding Fittings and Forged Steel Flanges. They're available in a complete range of sizes and types in carbon steel and the B&W CROLOYS.

THE NATURAL SOURCE FOR ALLOY FITTINGS

B&W TUBULAR PRODUCTS DIVISION

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION • FITTINGS DEPARTMENT
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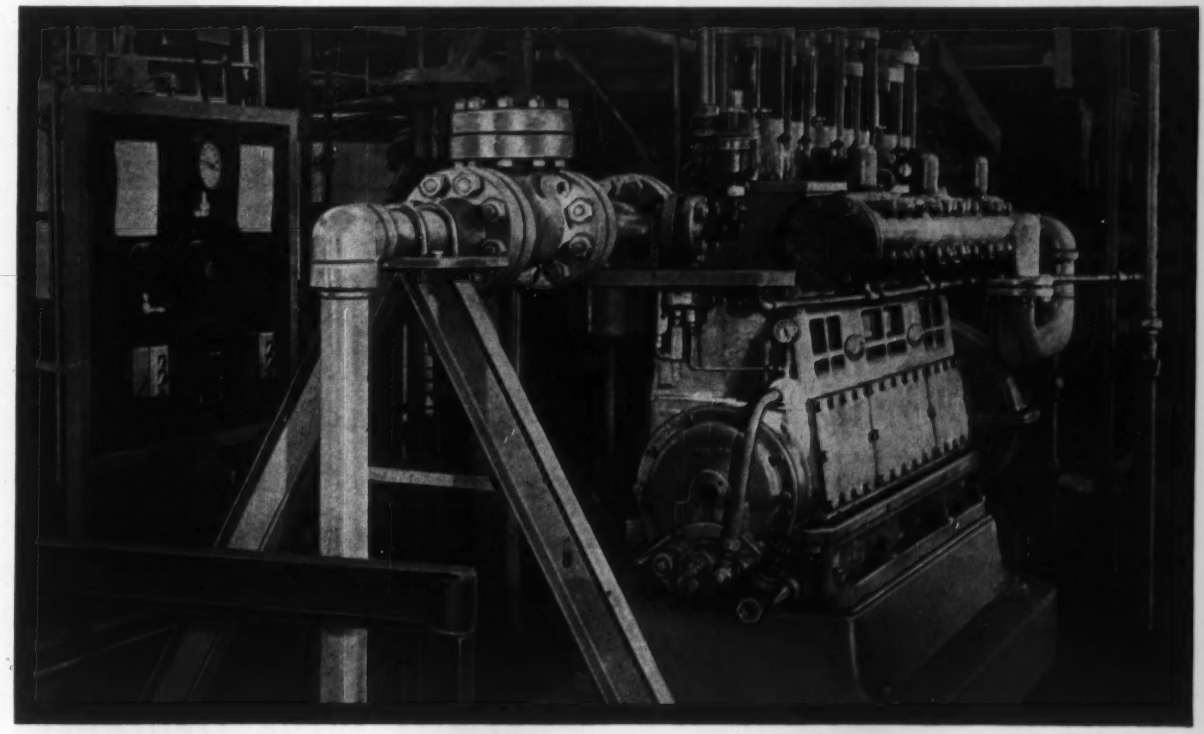
Seamless welding fittings and forged steel flanges, seamless and welded tubular products — in carbon, alloy and stainless steels.

MIDWESTERN DIE CASTER FINDS ANSWER:

How to pump hydraulic fluids non-stop when downtime means loss of production

During "rush seasons," when shifts work around the clock, this large midwestern manufacturer must have constant, dependable hydraulic power. One hundred percent capacity can only be maintained when the hydraulic system delivers a steady output pressure with no downtime.



How the problem was solved: Foreseeing 24 hour days, seven days a week, the die caster turned to Aldrich. As new facilities were added, so were Aldrich Pumps. The first, a 250 gpm pump, was installed four years ago. Since then, three more 207 gpm pumps have been added. All are 2¼" x 5", 1500 psi, gear driven Aldrich Septuplex Pumps, equipped with 200 hp motors.

Result: Just what you'd expect of an Aldrich Installation—steady dependability for continuous operation—highest reliability for intermittent service. Maintenance is held to a minimum. Operating efficiency has remained constantly high. Get full information on Aldrich Pumps and their advantages. Write the Aldrich Pump Company, 29 Gordon St., Allentown, Pa.

the toughest pumping problems go to ALDRICH

TURBINE BLADES CAN'T FOUL!

The Terry solid-wheel turbine is of the impulse, helical flow type. The steam issues from an expanding nozzle at high velocity and enters the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is returned to the wheel several times until practically all of the energy has been utilized. This principle makes possible the efficient use of steam in a single-piece, almost indestructible wheel.

Terry solid-wheel design permits large clearances

In the Terry solid-wheel turbine, the steam enters the buckets in a direction at right angles to the shaft, as shown above. This design eliminates the need for close clearances and provides positive blade protection.

The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, projecting rims on each side of the buckets prevent damage to the blades even though external thrust should move the wheel.

This is only one of the many advantages of Terry solid-wheel turbines. Write for complete details. Ask for a copy of bulletin S-116.

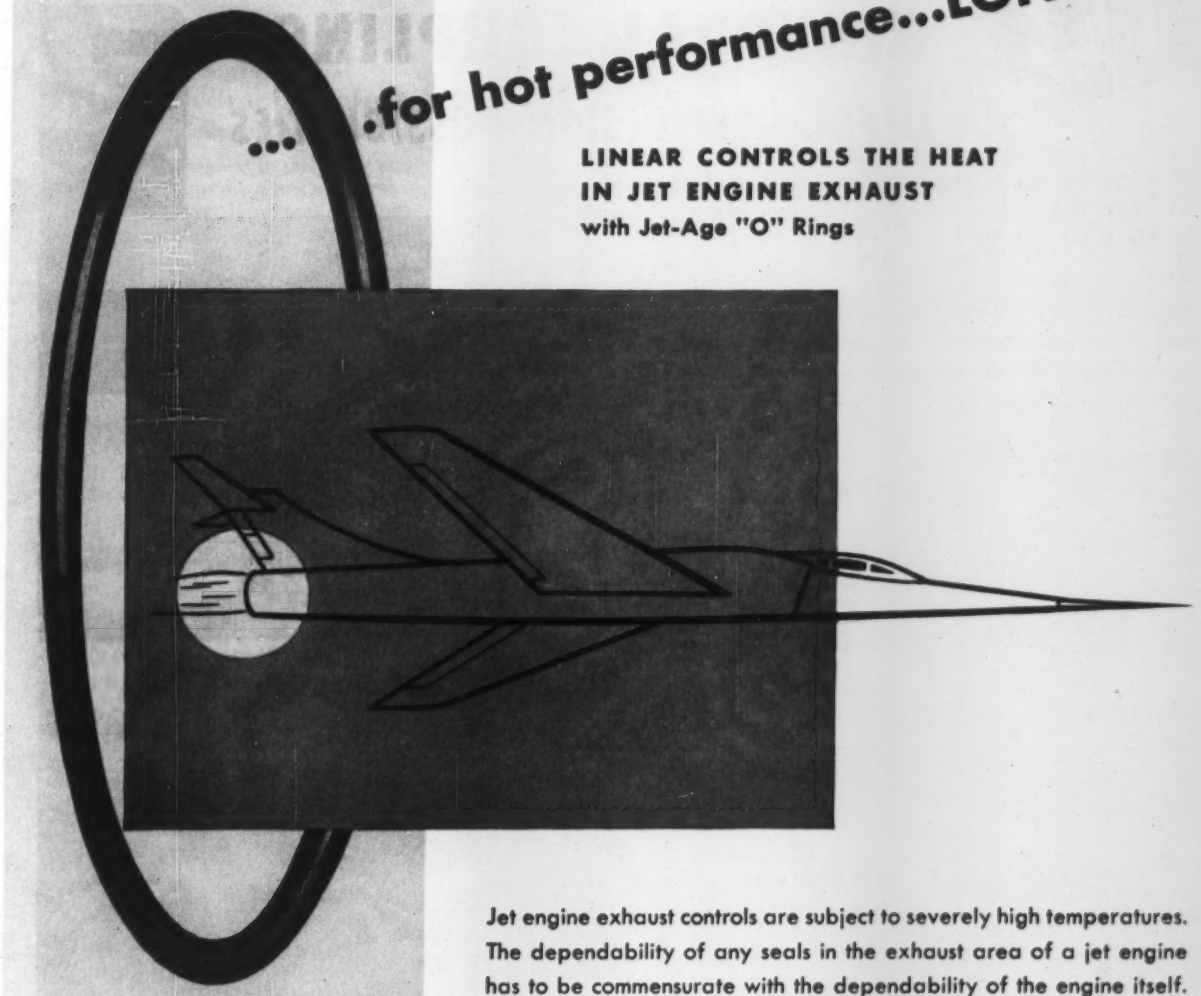
TERRY

TT-1206

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

...for hot performance...LONGER

LINEAR CONTROLS THE HEAT IN JET ENGINE EXHAUST
with Jet-Age "O" Rings



Jet engine exhaust controls are subject to severely high temperatures. The dependability of any seals in the exhaust area of a jet engine has to be commensurate with the dependability of the engine itself.

LINEAR'S ability and extensive experience in the design and manufacture of precision "O" rings—in such modern, heat-resistant elastomers as the silicone family—makes this kind of dependability a reality. LINEAR "O" rings, capable of withstanding intermittent ambient temperatures as high as 1000° F—and the destructive actions of gases and fluids, help control the jet engine exhaust—for hot performance—longer.

For a sealing problem of any kind—call on LINEAR or one of its agents for engineering assistance...

and be sure to Specify LINEAR "O" Rings for every application.

"PERFECTION IN RUBBER"
LINEAR
LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA 35, PA

AJAX

DIHEDRAL COUPLINGS

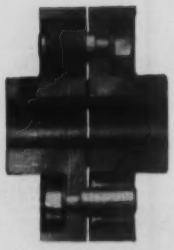
OFFER NEW DESIGN POSSIBILITIES

Now you can purposely design angular and offset misalignment into new machines as well as cure the same problems on existing equipment.

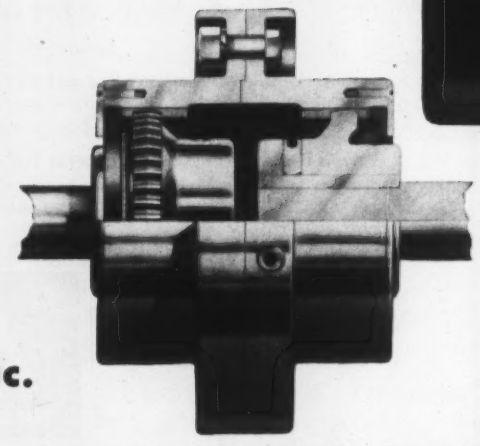
Ability to handle up to 12 degrees misalignment with constant peripheral speed is improving layout of driving and driven components, simplifying manufacture and reducing shut downs and maintenance of a wide variety of equipment.

Responsible For Radical Improvements

Radically improved performance is made possible by Ajax Patented Dihedral Tooth Shape. It has been proven by hundreds of installations involving angular drives operating at high speeds and horsepower. A discussion of their advantages may reveal important improvements resulting from their application to your conditions. Ajax representatives are fully qualified to give you the latest thinking on this advanced type of coupling.



Ajax Rubber-Bronze Cushioned Couplings have been the standard of industry for 37 years. Made in a complete range of sizes. Write for catalog.



AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, N. Y.

NUCLEAR NEWS FROM ATOMICS INTERNATIONAL

Continuing Progress at AI Advances Nuclear Technology For Many Tasks, in Many Lands

Highlighting progress in the many and diversified reactor programs at Atomics International are significant developments in the two major power reactor approaches underway by AI for the Atomic Energy Commission—the Sodium Reactor Experiment and the Organic Moderated Reactor Experiment.

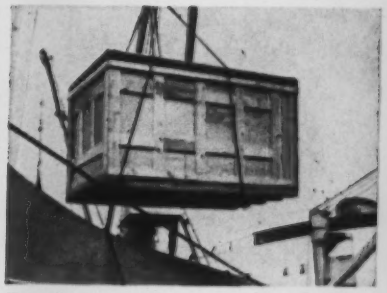
Forecasts Confirmed. On April 25 the 33rd fuel element was introduced into the SRE, and sustained nuclear fission was achieved. The critical loading confirmed earlier calculations. On July 12 heat from the SRE reactor was used by the Southern California Edison Company to generate electricity. This power was fed over utility lines to Edison consumers. Data obtained from the SRE will be used in the design of a 75,000 kw Sodium Reactor power plant proposed for the Consumers Public Power District of Nebraska.

Power Ashore, Propulsion Afloat. Similar studies are starting on the OMRE, recently constructed at the AEC's National Reactor Testing Station in Idaho Falls. This program will assist in the design of two 12,500 kw power stations, one in Piqua, Ohio, and another in a Latin American country. At the same time, the Organic Moderated Reactor is under study as a most promising nuclear propulsion system for the special needs of supertankers.

Reactors for the World. The Armour Research Reactor, first private industrial nuclear facility, is now being followed by a stream of similar research reactors—for Japan, Denmark, West Germany, West Berlin and Italy—constructed, shipped, and installed by Atomics International. AI's latest development is the compact Laboratory Reactor, available on a short delivery schedule at very low cost to meet the need for nuclear training and research in universities and industrial laboratories.

ATOMICS INTERNATIONAL is a leading designer and builder of reactors for America and for the world. For help on your reactor plans, write: Director of Technical Sales, Department ME-74, ATOMICS INTERNATIONAL, P. O. Box 309, Canoga Park, California. Cable Address: ATOMICS.

Critical Moment: On April 25, the SRE achieved sustained nuclear fission. Electricity was generated on July 12.



Destination—Denmark: Nuclear reactor components from AI are hoisted aboard a freighter for Copenhagen.

For Land and Sea: A versatile nuclear reactor concept—the OMRE.

Nuclear Research in Japan: Home of Far East's first reactor will be Japan's Atomic Energy Research Institute.

New Laboratory Reactor: Eight-foot-high tank contains fully functional core, coolant and moderator.

Reactor Hardware for Germany: Components for two German reactors in work at ATOMICS INTERNATIONAL.

ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.
PIONEERS IN THE CREATIVE USE OF THE ATOM

A tremendous structure — the new $26 million Elmhurst General Hospital in New York City.

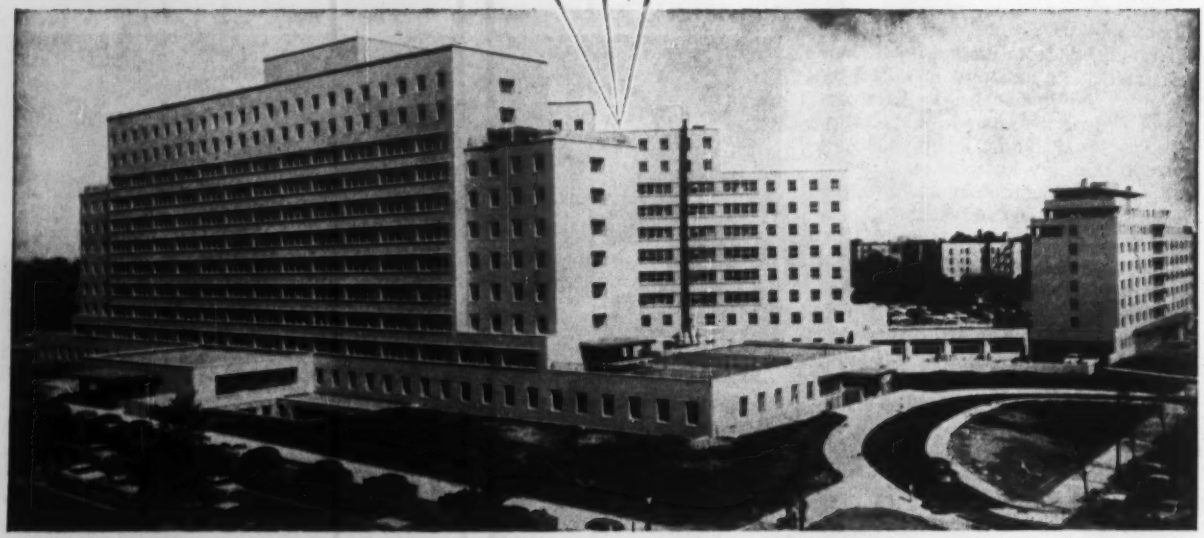
Another important assignment for Clarage — totalling 107 Multitherm air conditioning units, Unicoil sprayed coil units, giant system fans, and Ready Unit ventilating sets.

Why is this equipment so often selected for buildings of all types, all sizes? It's simply this: Clarage's recognized ability to operate quietly, economically, dependably. Call us in. You too will find it's characteristic of Clarage equipment to prove out successfully no matter how exacting the requirements.

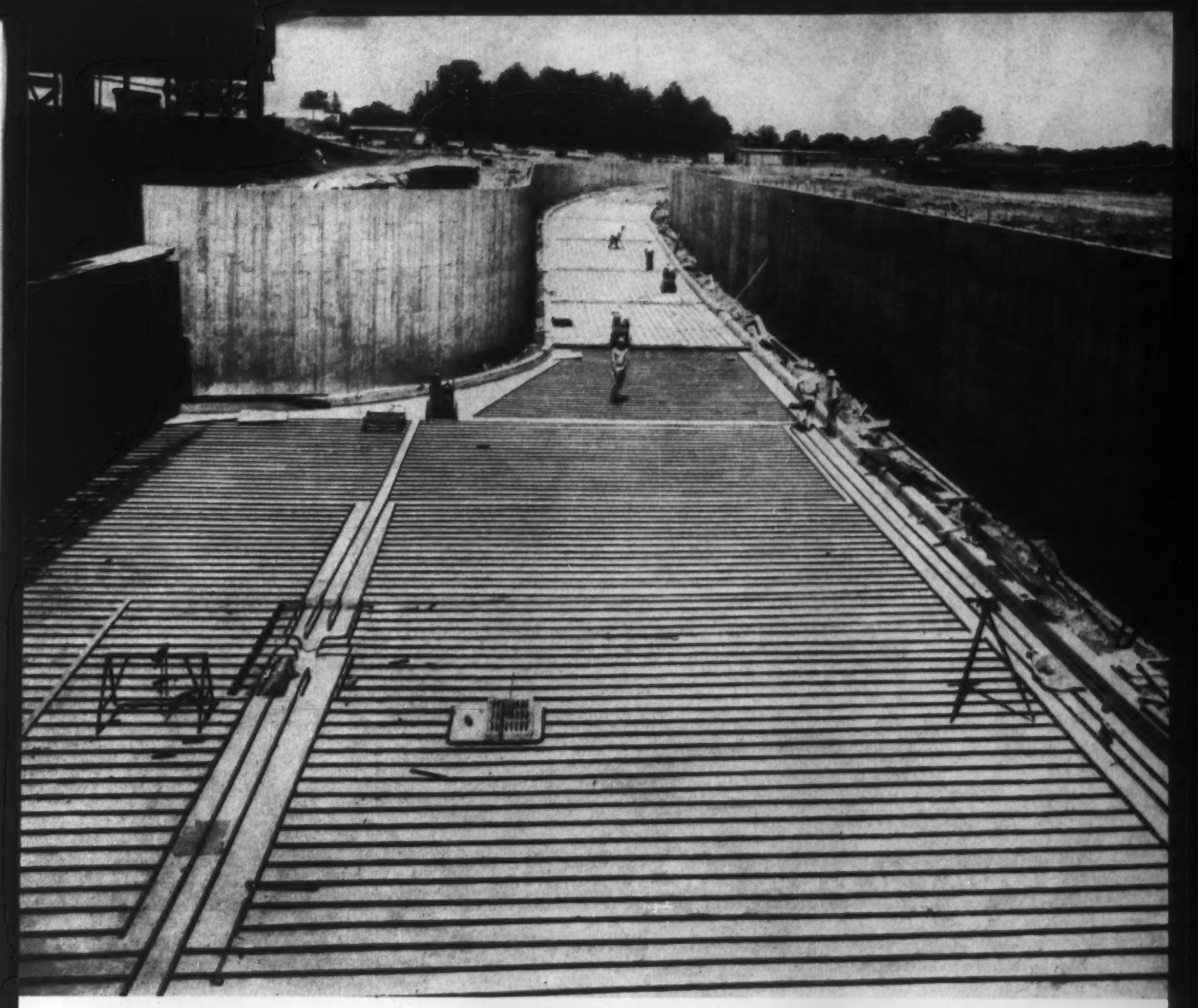
CLARAGE FAN COMPANY

KALAMAZOO, MICHIGAN

CANADA FANS, LTD. MONTREAL, CANADA



CONSTRUCTION supervised by N.Y.C. Department of Public Works ARCHITECTS AND ENGINEERS — York & Sawyer and Fellheimer & Wagner CONTRACTOR — Diorks Heating Co., Inc.



Built-in snow removal called for piping dependability —they used Wrought Iron

Not just snow melting—but *dependable* snow melting—was the leading design objective for this access ramp.

That's why designers of the new Connecticut General Life Insurance Company office building gave such careful consideration to material selection for this access ramp. Four major factors supported the use of wrought iron for this job: its corrosion-resistance—rugged strength—low coefficient of expansion with concrete—ease of fabrication.

In addition to snow melting service, wrought iron pipe was also installed for well water and cold water lines, chilled water mains, and well water piping in the heating and cooling system. Our booklet, "Byers Wrought Iron for Snow Melting Systems," offers case-history support for wrought iron's reliability in this service. Write for a copy.

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Division Offices in Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, San Francisco. International Division: New York, N.Y.

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Contractors: Turner Construction Company, New York, N.Y. (General Contractors)
Cobra Pipe and Coil Company, Elmwood, Conn. (Snow Melting)
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Kerby Saunders, Inc., New York, N.Y. (Heating and Air Conditioning)

BYERS Wrought Iron Tubular and Hot Rolled Products

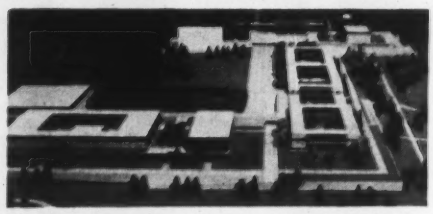
ALSO ELECTRIC FURNACE QUALITY STEEL PRODUCTS

TODAY'S NEW IDEA IN BIG-SPACE HEATING

Maybe hot-water heating doesn't sound like a new development to you. But it may be news to you that water at very high temperatures — up to 470° F and 500 pounds pressure — is coming to the fore as an advantageous method of heating large areas.

A big factor in bringing this trend about is the C-E LaMont Controlled Circulation Hot Water Boiler. Using the same principle applied by C-E in many of the country's largest utility boilers, this new boiler provides a degree of temperature control that makes it the most attractive method of heating in many cases. Examples of highly successful applications are industrial plants, large institutions, air bases and other military installations.

There are many cases, of course, where steam may still be the best choice. But here is an important point: whichever may be best for you, C-E, with its complete line of boilers of all types, can supply the equipment best suited to your particular situation. And, Combustion's wide experience is available to you and your consultants in finding the right answer. For details on C-E high-temperature water boilers, write for Catalog HCC-2.



Model of the country's newest service school, the U. S. Air Force Academy at Colorado Springs, where five C-E Hot Water Boilers will serve living, academic and service areas. Recognition of this system's advantages is shown by the fact that this same type of equipment is in service or on order for such Air Force Bases as Dover, Portsmouth, Forbes and McGuire . . . for industrial plants like Convair Astronautics Div. of General Dynamics Co., The Cross Co., Erie Mining Co. and Marquardt Aircraft Co. . . . and for such institutions as the A. E. Smith High School in Riverview, Mich.

COMBUSTION ENGINEERING

Combustion Engineering Building
200 Madison Avenue, New York 16, N. Y.

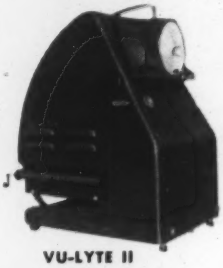
B-991

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

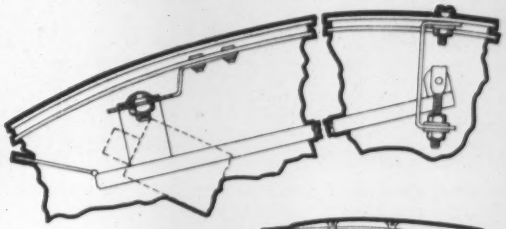
Waldes Truarc Rings cut assembly costs, improve performance of precision photo-optics equipment

Charles Beseler Co., E. Orange, N. J. uses Waldes Truarc Retaining Rings in 3 applications shown.

REFLECTING MIRROR ASSEMBLY IN OPAQUE PROJECTOR

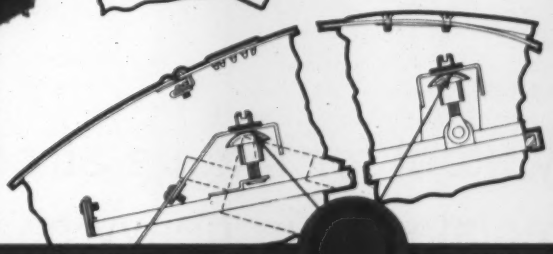


VU-LYTE II PROJECTOR



BEFORE

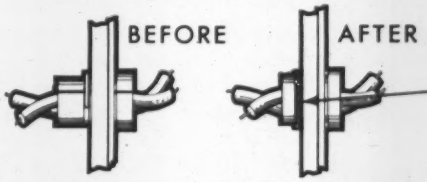
"The front surface mirror is the most precise optical element in a properly-functioning opaque projector," Beseler writes. "Previously we used this extremely cumbersome means of holding the mirror in position. As mirror adjustments are always required and the mirror is extremely delicate, our spoilage was terrific."



AFTER

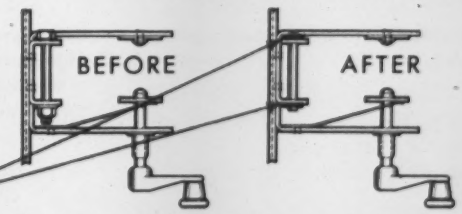
"Two Truarc Series 5100 Rings made possible complete redesign of the mirror assembly. Now mirrors can be adjusted from *outside* the projector. Rejects now are practically nil. More precise adjustment of the mirror is possible. And because of the greater ease in adjustment, we have cut labor costs $2.00 per unit."

HEAT ASSEMBLY IN PRINT DRIER



Here a Waldes Truarc crescent ring, Series 5103, replaced a split collar and clamping ring. Results: labor costs cut 50¢ per unit because of greater ease of assembly. Drier provides more uniform heating.

35 MM MICRO-FILM NEGATIVE CARRIER IN ENLARGER



2 Waldes Truarc Series 5133 E-Rings replaced 2 cap nuts—at a saving of 20¢ per unit in labor costs.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U.S. and Canada.

Controlled Quality from engineering and raw materials through to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC.
47-16 AUSTEL PLACE, L. I. C. 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C. 1, N.Y.
Please send new, descriptive catalog showing all types of Truarc rings and representative case history applications. *(Please print)*

Name _____

Title _____

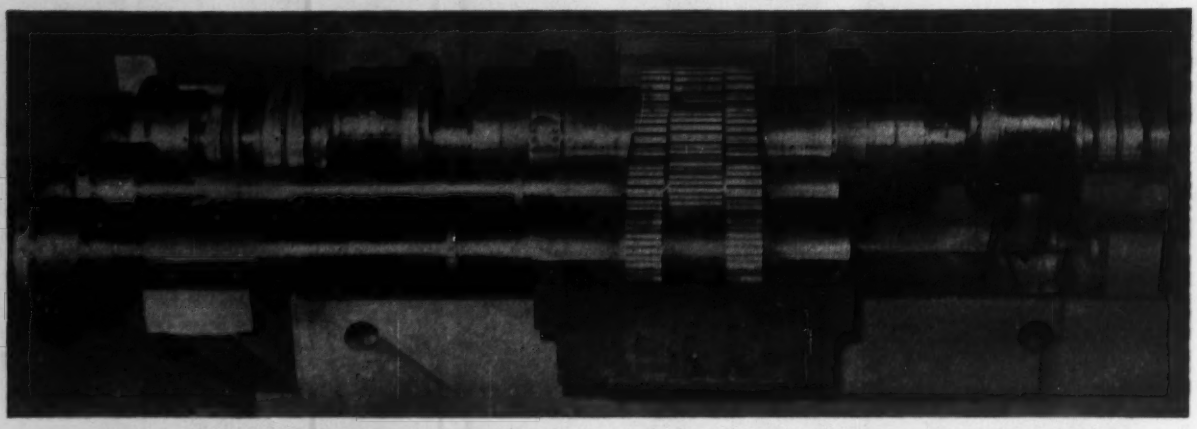
Company _____

Business Address _____

City _____ *Zone* _____ *State* _____

ME09

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U.S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U.S. Patents pending. Equal patent protection established in foreign countries.



Assembled main shear shaft and front gate drive shaft used in model 541 guillotine flying shear. Shafts range up to 9¼" in diameter and 16' in length. All shafts are fabricated of type 4340 nickel alloy steel.

Giant "flying" shears need...

Nickel alloy steel for fatigue strength and shock resistance in heavy shafting

Cutting metal strip is a shaft breaking job!

It takes enormous blade pressures applied as much as 180 times a minute 250,000 times a day. That's rough on the shafting that activates the shears.

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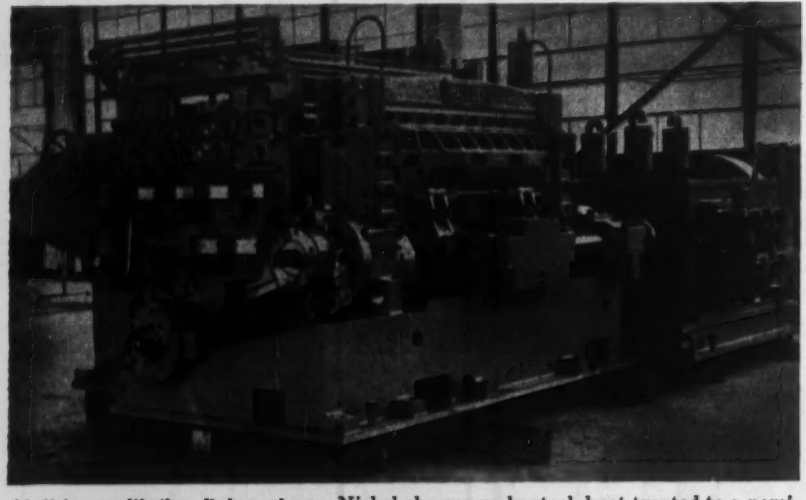

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SEPTEMBER 1957

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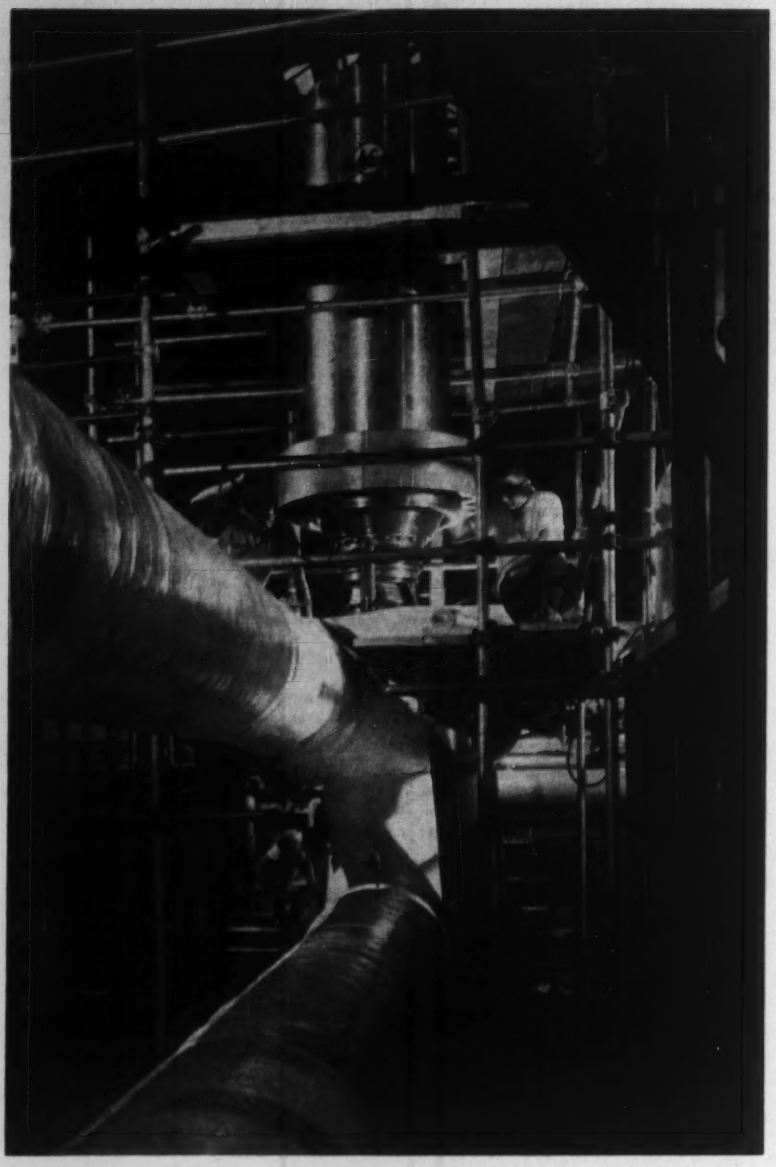


Canned-motor pump

This Allis-Chalmers 18,300-gpm, 111-psi, hermetically sealed, canned-motor pump being lowered, is one of the coolant pumps destined for the Shippingport Pressurized Water Reactor power plant. It will circulate radioactive water through the reactor and heat exchanger. Because conventional bearing materials, packings, mechanical seals, and lubricants present problems in high-temperature, high-pressure corrosive pumping, the pumps use the Allis-Chalmers fluid piston bearing with rotor and impeller positioned by the fluid pumped. Rotor and stator are encased in thin steel cans with the circulating fluid in the "air" gap as a coolant.

Volume 79 • Number 9

SEPTEMBER 1957

George A. Stetson, *Editor Emeritus*
J. J. Jaklitsch, Jr., *Editor*

MECHANICAL ENGINEERING

Improving Science Instruction

CALIFORNIA, like many other industrial states, is plagued with a shortage of engineers and the problem of improving science instruction. But something is being done about it! Steps are being taken co-operatively by California's leaders in science, education, and industry to resolve this dilemma. For example, nearly 100 leaders gathered for a national industry-education conference, at Lake Arrowhead, Calif., July 7–13, 1957, to take a cool and clear look at the nation's scientific manpower shortage. Sponsors of the conference were the National Academy of Sciences and Hughes Aircraft Company of Culver City, Calif.

For five days the conference delegates heard national authorities outline the dimensions of the manpower problem. Government experts warned that "the scientific manpower shortage can be ended only in the local classroom" by improved teaching of science courses from grade school through junior college. A U. S. Office of Education specialist pointed out that the number of new science and mathematics high-school teachers has dropped more than 50 per cent between 1950 and 1954, and only now is beginning to climb slowly toward 1950 levels.

When the conference adjourned, the delegates had:

Established a permanent Southern California Industry-Education Council (SCIEC), with a full-time paid executive secretary and a five-man steering committee representing both industry and education.

Appointed five area "salesmen" for Southern California, each with the responsibility of bringing together more industries and schools to improve science teaching.

Approved a drive to raise funds from industry for running the new Council, and received informal assurances from industrial delegates that the needed money would be forthcoming.

Agreed to publish a manual, with the backing of the National Academy of Sciences, to show other areas how to start their own programs.

SCIEC is moving fast. Steering committee members predict that Southern California will shortly have a mushrooming program of industry-education co-operation from Fresno to San Diego.

In line with the Southern California program a special forum for high-school guidance counselors and science teachers from the San Francisco area, including representatives from colleges and industry, was organized during the recent ASME Semi-Annual Meeting in San Francisco, Calif. Its purpose: To encourage more youngsters to enter the engineering profession—and to improve science education.

Thus far, six meetings have been held, and the one preliminary conclusion reached points out that results can be obtained if each engineer and scientist will participate in one or more of the following activities:

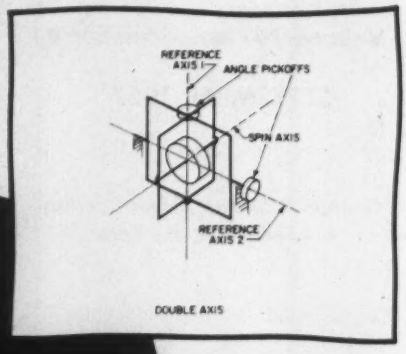
Student counseling and assistance in projects; counseling and co-operation with guidance counselors, science and mathematics teachers; local, county, and state school boards; and committee work for any or all of the numerous phases of a comprehensive program.

Reports of these activities appear in this month's "Roundup."

Both Southern and Northern California have recognized the problem of school enrollments, teacher preparation, and production of scientists and engineers, and are attacking it with vigor. Both programs are worth watching for largely through the co-operative efforts of education, industry, and professional societies will the engineering shortage be sensibly relieved.

By J. M. Slater, Autonetics Division,
North American Aviation, Inc., Downey, Calif.

Gyroscopes for Inertial Navigators



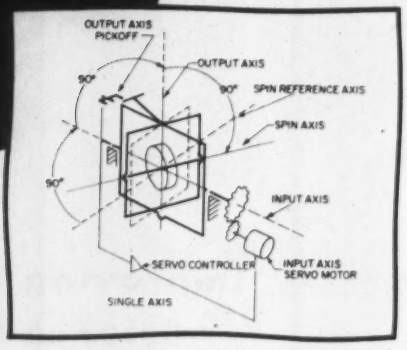


Fig. 1 Gyroscope terminology, double axis, *above*, single axis, *below*

An inertial navigator is an apparatus for finding velocity and position of a vehicle by sensing and integrating vehicle accelerations. In general, it includes a set of acceleration-sensing devices, stabilized so as to retain some predetermined space orientation independently of changes of attitude and heading of the carrying vehicle. Such orientation may be, for example, level with one acceleration-sensing axis north-south and the other east-west. To maintain such directions, the acceleration-sensing devices are mounted in some relation to a gimbaled platform which is stabilized with the aid of gyroscopes.

The primary function of the gyroscopes used in inertial navigators is to establish a set of reference axes which remain in some known relation—for example, angularly fixed—in inertial space. To the extent that perfect stabilization is achieved, the outputs of the acceleration-sensing devices can be interpreted as changes of vehicle motion in a particular co-ordinate system, commonly a latitude-and-longitude system.

Contributed by the Aviation Division and presented at the Semi-Annual Meeting, San Francisco, Calif., June 9–13, 1957, of The American Society of Mechanical Engineers. Condensed from ASME Paper No. 57—SA-39.

Gyroscope drift results in velocity and position errors. The nature of the error function is complex. However, a good general idea of the effect of drift is readily obtained when one considers that the gyroscope assembly is utilized as a sort of substitute for the sun and stars of celestial navigation, where a comparison is made of the direction of a reference line to a celestial body with the direction of vertical obtained from a natural or artificial horizon.

In inertial navigation, the gyroscopically stabilized platform may be regarded, broadly speaking, as the counterpart of the celestial-space directional references. A platform drift of 1 deg is the equivalent of an imaginary shift of 1 deg in the reference star, and an error of approximately 60 nautical miles can result at the earth's surface.

It is apparent that, to make inertial navigation competitive with other means of velocity and position finding, gyroscope drift rates must be reduced to extremely small values.

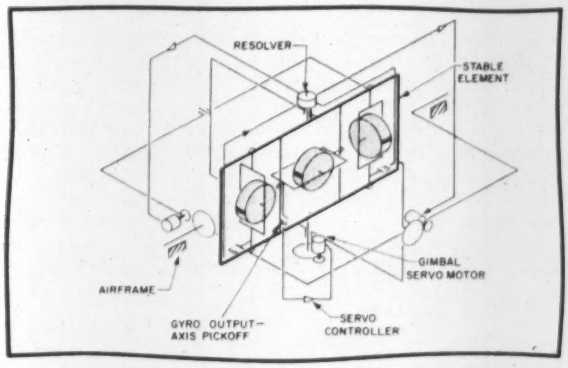
Requirements of the Gyroscope

The requirements of a gyroscope for inertial navigation are indeed remarkably severe compared with requirements in most other applications. In Table 1, tolerable "drift-rate" ranges are roughly outlined. An exact specification would demand considerable discussion. For present purposes, what is referred to is a median

Table 1 Accuracy Requirements of Gyroscopes

Type of Gyroscope	Gyro drift-rate requirements
Rate gyroscope for fire and flight control	10–100
Directional gyroscope and gyro-horizon for flight indication and autopilot applications	1–10
Polar (high-latitude) directional gyroscope (a high-grade directional gyroscope, compensated for earth rotation, used as a reference in traversing the arctic region)	0.1–1
Gyrocompass (ship-borne); marine gyro vertical	0.01–0.1
Gyroscope for inertial navigator	At least equal to type 4

▼ Fig. 2 A gyroscopically stabilized platform is the rough counterpart in inertial navigation of the star directional references used in celestial navigation



value. A drift rate of N deg per hr means that, at the end of the first half hour in a large number of tests of a quantity of a given type of unslaved gyroscope, half of the tests will show higher, and half lower, average drift rates than N.

The first two types mentioned have low-accuracy requirements because the error is bounded by having the gyroscope slaved to a gravitational or magnetic reference, or else the instrument is used for short-period control only. In the polar directional gyroscope, requirements are not low and attaining them has been a matter of considerable difficulty.

The Gyrocompass

Gyroscope performance of a moderately high degree of precision has been attained for decades with the gyrocompass, whereas high-precision performance has been attained only recently in air-borne inertial-navigation equipment.

Successful application of the gyrocompass is due partly to the fact that its error is bounded. Injection of a heading error into a dead-reckoning problem is usually a far less serious thing than the position-error build-up which the same gyroscope could introduce into an inertial navigator. A 0.6-deg heading error would amount to only a mile in a 100-mile run, whereas the same gyroscope incorporated in an inertial navigator could cause error build-up at the rate of 6 nautical mph.

The gyroscope of a gyrocompass ordinarily is used in an orientation such that mass unbalance results in no moment under the acceleration of gravity. Thus the instrument is virtually immune to the chief potential source of disturbance under marine conditions.

Fire-Control Gyros

Similar considerations apply to the marine gyrovertical, as used for fire-control purposes. The limiting factor on accuracy is usually not gyroscope drift but rather the degree to which the disturbing effects of earth rotation, and of accelerations other than gravity, can be taken into account. Since the gyroscopes are slaved to gravity references (for example, liquid levels), drift rate gives rise not to a cumulative error but rather to a steady deflection which can be kept to an extremely small value by skillful design.

Except in special cases, inertial-navigator gyroscopes can receive no benefit by slaving to gravity or other directional references. In general, they must run free or open-loop.

Furthermore, navigation gyroscopes may have to function in an extremely unfavorable acceleration environment. Even in moderate-performance aircraft, horizontal accelerations are by no means negligible. In high-performance aircraft, and certain missiles, multigravity accelerations can exist in any direction. The accuracy of a one-gravity gyroscope can readily be degraded by one or two orders of magnitude in certain such applications.

Gyroscopes for Inertial Navigators

Gyroscopes for inertial navigators may be classified as double-axis and single-axis types, Fig. 1.

In the double-axis type, the spinning rotor is mounted in a two-axis gimbal, or the equivalent, constructed to minimize friction and other sources of disturbing torque on both axes. To the extent that such torques approach zero, the rotor will maintain an initially set direction in space. Angular-displacement information may be obtained at the gimbals by suitable pick-offs. The familiar "gyro-vertical" is an example of a two-axis gyroscope.

The rotor-carrying gimbal itself cannot very well be used as a support for accelerometers or other massive equipment to be stabilized, because successful operation depends on keeping stray torques to the absolute minimum. Thus in precision applications a follow-up platform is provided. This is a gimbaled base for the two-axis gyroscope which is maintained orthogonal to the spin axis by means of a pair of servo systems controlled from pick-offs at the gyroscope gimbals. Objects to be stabilized are attached to the platform and do not load the sensitive elements. The servo systems are essentially position follow-ups; dynamic characteristics of the spinning rotor do not enter into consideration.

To establish a three-axis or universally stabilized platform, two double-axis gyroscopes are required, with spin axes disposed at right angles. This leaves one redundant reference axis, which can simply be "killed" by use of a null slaving system, or made use of in various ways.

In the single-axis type of gyroscope, two degrees of freedom are provided as in the double-axis type, but only one of the two axes, which may be the outer gimbal axis, is used for reference. The rotor spin axis is maintained at right angles thereto by a servo system which includes a pick-off for sensing deflections about the inner gimbal

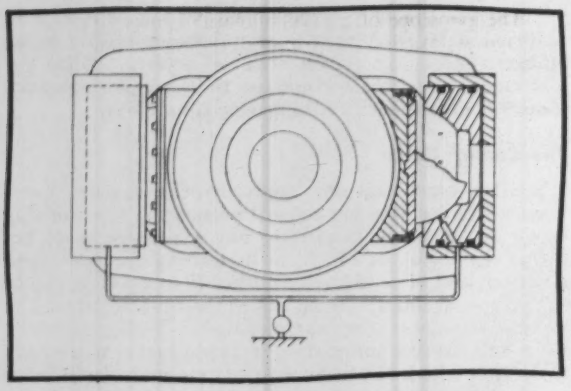


Fig. 3 A patented gas-lubricated gyroscope-gimbal bearing floats the gimbal with gas under pressure, introduced into the gap through minute restrictors

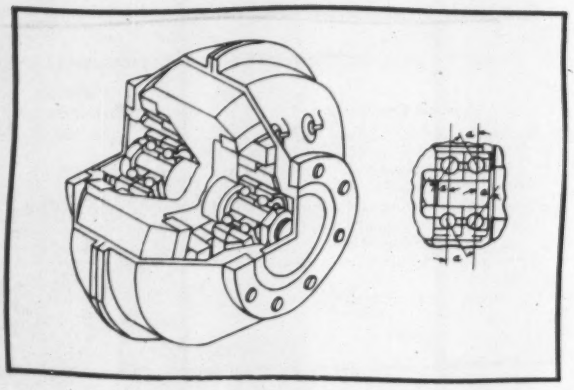


Fig. 4 A patented navigator-gyroscope gimbal assembly employing preloaded bearings with specially designed rotor and housing shapes

axis, and a servo motor operating at the outer axis in a sense to bring the pick-off signal to null.

In the standard nomenclature for single-axis gyroscopes the "spin axis" is the actual axis of revolution of the rotor. The support axis of the gyroscope gimbal, which is established by construction at right angles to the spin axis, is termed the "output axis," or sometimes more loosely the "precession axis." The "spin reference axis" is established by placement of the null of the output-axis pick-off and maintained by proper servo functioning; it coincides with the direction of the spin axis in its normal undeflected position. The "input axis," sometimes loosely called the "stabilizing axis," is defined as the axis at right angles to the output and spin-reference axes. It is an axis in space and may, or may not, coincide with the axis of rotation of a particular shaft, axle, or other part of the apparatus.

Single-Axis Gyroscope

A single-axis gyroscope differs from the two-axis form in two important respects:

1 A reasonable amount of disturbing torque can be accommodated, at the input axis, without causing appreciable precession, that is, error, about such axis since this axis is used only for torque-sensing purposes, not as a space reference. Thus the problem of minimizing disturbing torque is reduced to a single axis—the output axis.

2 The gyroscope is a dynamic part of the stabilizing servo loop. Instead of a straight position follow-up, we have a system wherein an input-axis-disturbing torque is integrated, by the gyroscope, as an output-axis precession velocity, which integrates to a precession angle sensed by the output-axis pick-off, the pick-off then calling up a counter-torque via the servo system.

Three single-axis gyroscopes are required to establish a three-axis reference or stable platform of the type shown in Fig. 2. The set of gyroscopes is mounted, with orthogonal input axes, on a frame. The frame is mounted in gimbals for three degrees of freedom relative to the vehicle, the gimbals being under servo control from the gyroscopes. Disturbing torques acting on the frame are sensed by the gyroscopes as output-axis precession, and counter-torques are called up via the servo system which is controlled from pick-offs on the gyroscope output axes. Since the platform gimbals provide universal angular freedom for the frame, the necessary input-axis freedom is provided for all the gyroscopes. The gyroscope, whose input axis is vertical, controls the azimuth-gimbal servo motor directly. Since the input axes of the other gyroscopes change their relation to the platform gimbal axes, with changes of vehicle heading, the stabilization signals have to be resolved by a resolver; for example, a two-phase synchro.

To avoid duplication, further discussion will be confined to single-axis gyroscopes, since the principal difference between double and single-axis gyroscopes is the number of axes to be kept torque-free.

Precession Rate

Precession rate (angular velocity) ω about the input axis, due to torque L about the output axis, is related to L by Newton's second law in the form $L = \omega H$ where H is gyroscope angular momentum (rotor moment of inertia times spin velocity). In Table 2 is set forth the torque to give a rate of 0.01 deg per hr for gyroscopes of different angular momentums.

Torque

Torques may be grouped in two classes, according to whether they are of a nature independent of, or dependent on, acceleration. Torques of the first class will exist even when the gyroscope is on a stationary base with output axis vertical. Torques of the second class appear under certain conditions of sustained or vibratory acceleration.

Frictional or resilient coercion from pick-offs and other transducers, electrical lead-ins, and other fittings and accessories may be mentioned as examples of acceleration-independent torques. Any interaction between parts of the gyroscope with the earth's field and other stray fields is also acceleration-independent.

Attack on acceleration-independent sources of torque is partly along obvious lines. The designer avoids, for example, frictional devices such as potentiometers and slip rings. He also avoids such items as pick-offs of type wherein residual magnetism can result in a sensible torque or moment on the sensitive element. In general, moving-coil transducers are preferable.

In the earlier years of the precision-gyroscope art the

Table 2 Torque to Produce ω = 0.01 deg per hr

Gyro H gm-cm²/sec	L dyne-cm
10^6	0.005
10^8	0.05
10^7	0.5
10^8	5
10^9	50

NOTE: A dyne-cm is about equal to the moment exerted by the weight of 1 cc of air on a 1-cm moment arm.

Precession rate (angular velocity) ω about the input axis, due to torque L about the output axis, is related to L by Newton's second law in the form $L = \omega H$.

output-axis bearing was the main source of disturbing torque. Ball bearings, because of internal hysteresis, preloading, and retainers have friction-torque levels which, even under unaccelerated conditions, are one or more orders of magnitude higher than can be tolerated at the output axis of a navigator gyroscope.

Gas or Liquid Bearings

Support of the sensitive element—rotor, spin bearing, motor, and gimbal assembly—by gas or liquid is effective in minimizing output-axis torque. Properly designed gas or liquid bearings have strictly negligible coulomb or static friction, and very low resilient coercion, and are largely insensitive to load changes. They also have the necessary property of rigidly defining an axis. Some types of bearings, otherwise desirable, are too compliant, allowing the gyroscope axes to deflect angularly under the influence of torsional loads. Such deflection can constitute a trigonometrical source of error having the same effect as a gyroscope drift angle.

The gyroscope gimbal completely encloses the rotor and motor assembly, and has attached to it a pair of fused-quartz hemispheres, spaced by a very small gap from a pair of Invar sockets. One form of gas bearing[1] uses gas under pressure, introduced through minute restrictors into the gap, to float the gimbal.

Acceleration-Dependent Torques

Acceleration-dependent torques constitute a troublesome class. They are difficult to minimize because the masses involved are so large that even a tiny moment arm can result in an intolerable error. Also, they are the more difficult to detect. Detection requires subjecting the gyroscope to sustained and vibratory accelerations along various axes, while accurately maintaining its input axis in constant relation to the earth's axis. This avoids spurious drift rates from the picking up of unwanted components of earth-rotation velocity. The centrifuge, a very convenient device for producing multigravity acceleration along a rotating axis, is, however, of limited applicability in the testing of gyroscopes.

The most obvious source of acceleration-dependent torque is mass unbalance due to some permanent displacement of the center of mass of the senitive elements from the output axis. The degree to which balance can be achieved in fabrication is dependent mainly on quality of the output-axis bearing and rigidity of the structure. By proper care, a degree of balance can be achieved which is high and remarkably stable considering the complexity of structure of a gyroscope as regards number of parts and diversity of materials. But even a slight shift, measured in microinches, can bring the gyro out of tolerance, and if it occurs during flight, a serious error can result. Tolerances are so strict that not only creep of materials and slippage of joints come into play, but also differential thermal expansion across the output axis, and even such minutiae as the effect of a small drop of bearing lubricant wandering around inside the supported element.

Good gyroscope design is characterized by the use of stable materials and by extreme rigidity. This applies to the structure of the rotor, gimbal, and output-axis bearing; and also to excrescences such as pick-offs, torquers, and the like. One-piece rather than jointed construction is employed where possible. A high degree of symmetry about the output axis favors minimization of mass shift, not only from creep or slip but also from thermal differences.

A more insidious source of acceleration-dependent disturbing torque is that due to unequal compliance of the sensitive element, or some part of it, under acceleration in different directions. Such condition is termed "anisoelasticity." Consider, for example, a gyroscope rotor mounted in ordinary radial ball bearings which have substantially higher compliance along the axis of rotation than radially. Acceleration along either the output axis or the axis of rotation will cause no moment, but acceleration along an intermediate axis will cause a moment which, if the compliance is linear, varies as the product of the components of acceleration along the two axes. Furthermore, the moment is in the same sense if the acceleration reverses; vibratory acceleration results in a rectified torque, hence a net drift rate.

Even though ball-bearing deflections under load are measured in microinches per lb, great care must be exercised in fulfilling the isoelastic condition. The mass of a gyroscope rotor even on a microinch moment arm can result in substantial moments under high-acceleration conditions. Angular-contact bearings of about 35 deg contact angle have the isoelastic property.[2] Extreme care must be taken to establish and maintain the proper preloading to keep the required contact angle. Because of considerations of mass shift upon change of temperature, it is rarely practicable to fix one end of a gyroscope rotor shaft and let the other end float, as can be done in grinder spindles, and similar apparatus. Ordinarily, the angular-contact bearings are installed as one, or two, closely spaced pairs preloaded against each other.

Any other elastic part, such as the rotor, or the case, or some projection thereon, which has different compliance in different directions, can likewise give rise to a rectification torque as described. In some instances it is possible to match an excessive compliance of one part along one axis, by deliberately increasing compliance of another part along a perpendicular axis.

Fig. 4 shows a navigator-gyroscope gimbal assembly[2]

[1] Patent No. 2617695, November 11, 1952, assigned to North American Aviation, Inc.

[2] Patent No. 2649808, August 25, 1953, assigned to North American Aviation, Inc.

(Continued on page 857)

The Logic of ORGANIZATIONAL PLANNING

By T. F. Koch, Assoc. Mem. ASME
Chicago Rawhide Manufacturing Company, Chicago, Ill.

Organizational structure always exists, whether designed by wise leadership, or allowed to evolve by managerial default. What is organizational planning, how is it done, and why is it required for the efficient use of manpower and resources?

An organization exists because it is needed to do things its head is not doing. As an enterprise grows, people and machines are added to perform functions beyond the capacity of the head. He doesn't have the knowledge, he doesn't have the time, or it is simply more profitable to have some other person, or some machine, take over.

Organization assigns the separate functions of multi-purpose machines—or many-talented people— to separate "units" so as to make clear the manner in which the goal is achieved. It also collects into a single unit all machines or individuals performing identical functions so as to avoid the confusion of multiple listings. Hence, units become inseparable from their functions.

The common purpose is achieved by each unit performing its function. Conversely, since each function is required for achievement of the common goal, there must be certain relationships between these functions. It is this chain of relationships that makes up the organizational structure, and it is intrinsically present in every organization, whether planned or merely allowed to develop by uncontrolled growth.

Organizational structure can come about in one of three ways:

1 The trial of various possibilities, discarding those that fail, and nurturing those that show signs of success. This may work well.

2 Allowing one or more dominant units to regulate their own relationships, thus creating the pattern to which others must conform. Sometimes this works well —until "dictatorship" sets in.

3 Planning the relationships for maximum utilization of the capabilities of each unit of the organization. In this way, most of the poor arrangements are eliminated on paper before they are tried, and any that do go into effect are watched so closely they have no chance to fail badly.

The head of an organization cannot escape choosing one of these three methods of developing the structure. If he plans the structure and carefully checks the progress against the plan as new circumstances arise, he has maximized the chances of success for the enterprise. If he establishes some structure more or less at random and then watches it, alert to necessary changes, he is moving toward a successful, planned organization.

But if he establishes a structure (whether at random or by careful planning) and then neglects to watch its progress, some dominant force may step in and distort the plan. Or, if the structure did not fit the circumstances, the organization may die. Even if the structure was wisely planned, the circumstances may change and the structure remain static, with consequent decline of organizational efficiency.

If he tries to escape by doing nothing, he automatically has chosen to allow someone else to dominate the relationships that cannot be avoided. All may turn out well, except for the head who has been dominated out of his position.

If we narrow the focus to the two methods that deserve engineering attention—deliberate planning and trial-and-error—the choice hinges on the amount of information

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available about the constituent units. The trial-and-error method, intelligently applied, will furnish data for proper planning in the future.

Modifying the Structure

The structure will undergo modification through deliberate changes in the pattern. There may also be unconscious changes, due to failure or neglect on the part of some of the organizational units. Personnel and personal changes are always present. Finally, the necessity for changes in a structure is related to the frequency and amplitude of changes in the functions and units of the organization—variations in the activity level of functions or, in the extreme case, the addition of a new function or the discontinuance of an old one.

Some of the things that can cause these variations in a business are:

- Introduction of a new product.
- Introduction of a new model.
- Introduction of a new manufacturing method.
- Introduction of new manufacturing machinery.
- Introduction of new machinery for functions other than manufacturing.
- A change in the market acceptance of a product, the extremes of which are called "buyer's" and "seller's" markets.
- Acquisition of a new group of customers.
- Acquisition of a new employee.
- Changes in the personalities, interests, motivations, knowledge, or capabilities of the people on the job.
- Changes in the tax structure.

Knowing the nature of the business under consideration, one can estimate the frequency and amplitude of the changes in the organizational structure. Logically, only the head of the organization can make changes—unless he wants to allow them to develop in haphazard manner. He may have the required knowledge of the general capabilities and limitations of the machinery and individuals involved. He may even have remarkably detailed knowledge of the specific properties of the particular people within his organization, how they are changing, and how they want to change. But there are so many other functions requiring his attention.

The Staff Approach

It is suggested that the establishment of this function as a staff assignment will be advantageous in many businesses. By establishing a single point of concentration of information concerning the factors which must be considered in planning organizational structure, we gain all the common advantages of specialization. Since this concentration provides for advice on organizational planning at all levels of the structure, it also makes possible interchange of people between functional units, something that tends to be unlikely if each unit keeps its internal affairs to itself. Often this interchange is the only thing that will retain a man in the company when he is developing faster than the unit of which he is a part. Similarly, it enables a company to fill gaps without going outside for new people, when a unit grows faster than the people in it.

What, specifically, will this organizational planning agency do if it is established?

1 It will reduce to writing, for all to see, the mission of the organization. This simply assures that everyone knows the direction in which he must point if he is to be an asset to the organization.

2 It will list the functions that must be performed to accomplish this mission, subdividing them through successive steps until they (or groups of them) can be assigned to individual men or machines.

3 It will assume some tentative relationships between these functions, and make estimates of the characteristics of the units required to perform each of them.

4 It will examine the available people and machines to see how well they fit the tentative structure.

5 It will adjust the structure to fit the available men and machines, just as the engineer adjusts his design to fit available components.

6 It will note incompatibilities between available men and machines and the optimum structure, and will refer these to the proper authorities who will rectify the situation by improving or replacing the men or machines.

7 It will watch the changing factors, constantly, so as to adjust the structure when required.

8 It will keep itself informed regarding contemplated and probable changes in important factors, so as to anticipate the necessary adjustments in structure.

The Planned Organization

How will the planning agency operate?

It will gather its information by listening and observing and by asking questions, within its organization and outside.

It will analyze the accumulated data, possibly in conference with the head of the organization, and it will synthesize a plan.

It will present its plan to the head of the organization for his approval and action. The organizational plan will then be published.

The unplanned, "no red tape" organization works like this: Since each person in the organization must relate himself to certain others in order to do his job, he eventually visualizes some structure—one that fits his observations of the relationships around him, but does not necessarily agree with anyone else's visualization. Try to change this phantom structure by telling only those affected! It will take a long time, and the new picture may still not be right.

Now put a new employee in an organization with a published structure. He knows the facts right away, and can work more effectively through the proper people. True, he may notice discrepancies between the planned organization and the way it works, but so will an alert organizational planner, who will correct the situation. Making a change is still just a matter of telling those directly affected. But by recording the change on paper, and circulating it, the facts become known immediately, and no one needs to guess.

Does planning infringe on other already established activities? Not at all. It draws information from them, of course, but it performs an analysis and synthesis duty that is unique. For example, some personnel departments may be able to furnish information about people, but this is only the raw material to be operated on by the organizational planner. If we think of the personnel department as attempting to find square pegs for square holes, we can think of the organizational planning activity as first arranging the holes in the proper pattern, and secondly, shaping and sizing the holes to fit the pegs that are available.

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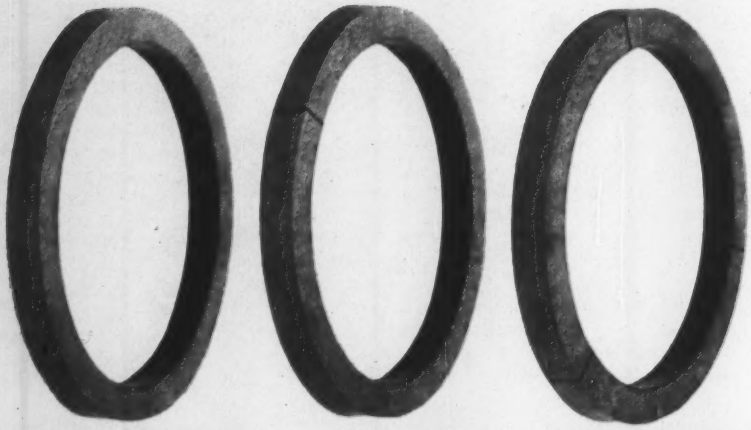

TEFLON-BASED[3] PISTON *for nonlubricated*

THE need for new materials which have the ability to operate without lubrication for gas and chemical-process compressors prompted an investigation into this problem. Carbon-graphite piston rings and wear rings generally used in nonlubricated compressors are fragile and often subject to excessive wear and breakage resulting in expensive shutdown time and overhaul.

The number of materials available for operation without lubrication is limited. Teflon-base material has such interesting properties that it may be well to describe briefly its composition. The structure of this tetrafluoroethylene resin consists of long straight chain molecules packed closely together. Its strong chemical bond between carbon and fluorine accounts for its exceptional resistance to heat and chemicals.

While exhibiting an extremely low coefficient of friction and self-lubricating properties, Teflon, by itself, does not have sufficient load-carrying ability to wear well, but it was found by early wear tests and tests of other investigators that these properties could be increased manyfold by compounding other materials with Teflon.

The K-30 material consists of Teflon specially compounded with fine-glass fibers which give the excellent load-carrying and dimensional-stability qualities essential for a successful piston-ring material.

Material Requirement

To meet the requirements for the wide range of operating conditions in nonlubricated gas compressors and chemical-process compressors, piston-ring and wear-ring materials should possess the following properties:

1 Wear resistance combined with compatibility with many cylinder materials in dry operation.

2 Chemical inertness for the maximum number of applications.

3 Thermal stability for both low and high temperature is essential.

4 Strength and flexibility in service and in handling, combined with resistance to cold flow under load.

5 Moisture-absorption freedom to eliminate swelling and insure dimensional stability.

Some of the materials investigated consisted of compounded Teflon, resin-bonded laminates, epoxy-bonded laminates, and Teflon-bonded laminates. Several compositions of carbon-graphite materials also were included.

Wear Tests for Screening Materials

A special wear-test machine was used for material evaluation. Proposed ring materials could be dry-wear tested under controlled-temperature speed and load conditions for compatibility with various cylinder materials. The wear-test machine utilizes the brake-shoe-loading principle for testing at room temperatures, and at ambient temperatures up to 1000 F. This type of machine has been used successfully for many years to evaluate piston rings and cylinder materials.

A standard-size specimen, called the rider is prepared from the material to be tested. The rider is 1 in. long, $^3/_8$ in. high, and 0.285 in. wide. The 0.285-in. width is in line contact with the $3^1/_2$-in-diam 1-in-wide wear-test drum at the start of the test. A load of 5 lb is applied to the rider against the drum throughout the test. The drum rotates with a surface speed of 1600 fpm. A new drum having a standard surface finish is used for each test. Wear is determined by weight loss in milligrams for the rider and drums for a 1-hr test.

For wear tests at elevated temperatures, the furnace hood is lowered over the rider and drum. The lever arm

[1] Design engineer, Technical Department.
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[3] Teflon is the trade name for E. I. du Pont tetrafluorethylene resin.

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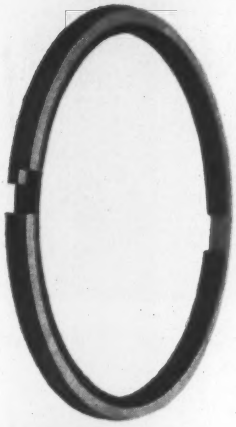

Three K-30 wear rings, *opposite page*, consisting of Teflon specially compounded with fine glass fibers, illustrating solid, one-piece split, and segmental types

Two-piece sealing ring, consisting of K-30 step-joint outer, and metallic inner ring

RINGS
applications

holding the rider is blocked up so as not to contact the wear-test drum. The wear-test drum is rotated at the proper speed, and when the desired temperature is obtained the lever arm is lowered so that the rider is in contact with the rotating drum. After 1 hr of testing and a cooling period, rider and drum are each weighed to determine the weight loss.

Table 1 shows the wear-test results on some of the materials tested at room temperature and 400 F ambient temperature. It was interesting that the friction between the rider and drum was so great with carbon-graphite materials at 400 F that the $^3/_4$-hp driving motor would stall during the test. The tests could only be completed by running a single specimen at a time instead of the customary two.

The Teflon-based materials exhibited excellent wear resistance at both temperatures, with an insignificant difference between Teflon and glass-cloth laminate and the Teflon and glass-fiber molding.

Material Selection

Chemical inertness, strength, and moisture resistance also were reviewed. Table 2 summarizes the results. The Teflon materials appeared to show considerable advantage. The Teflon and glass-molded material has distinct advantage in comparison to the Teflon and glass laminate. Material loss in machining moldings is considerably less than when machining laminates. Owing to the absence of laminations, the molded material possesses freedom from the possibility of lamination separation in machining or in service, and also freedom from swelling which sometimes occurs in laminated material when exposed to certain gases.

On the basis of the wear tests and the properties as described, the Teflon and glass-molded material was selected for piston rings and wear rings for nonlubricated gas and chemical-process compressors. A specification was prepared for a Teflon and glass-molded material which was designated as K-30 material, based on Teflon, Table 3.

Table 1 Wear Tests, Various Materials Vs. Cast Iron

Material	70 F ambient temp — Rider	70 F ambient temp — Drum	400 F ambient temp — Rider	400 F ambient temp — Drum
Laminate—cotton fabric bonded with resin plus graphite	2.8	0.8	248	+2.1
Laminate—cotton fabric bonded with resin plus molydisulfide	14.7	0.4	194	3.7
Laminate—asbestos fabric bonded with resin	1.0	0.5	90	2.3
Laminate—glass cloth fabric bonded with epoxy resin	72.1	10.4	102	8.3
Molding—1 carbon-graphite	—	—	16.3	2.3[a]
Molding—2 carbon-graphite	3.5	0.3	23.8	+0.7[a]
Laminate—glass cloth bonded with Teflon	1.1	0.5	19.7	2.7
Molding—K-30 Teflon glass fibers	1.6	0.3	18.0	3.8
Molding—Teflon/graphite	27.0	+0.3	—	—

[a] Intense friction necessitated running one specimen at a time.

Table 2 General Material Properties

Material	Wear resistance	Chemical resistance	Heat Resistance, max temp	Strength and flexibility	Moisture resistance
Resin-bonded cotton-fabric laminates	Fair	Fair	275 F	Fair	Fair
Epoxy-bonded special type laminates	Fair to good	Good	350 F	Fair	Good
Carbon-graphite types	Good	Excellent	700 F	Poor	Good
Teflon and glass	Excellent	Excellent	500 F	Excellent	Excellent

Table 3 K-30 Material Specification

Property	Method	Value
Tensile strength, 73 F, psi	ASTM-52T	3000 min
Flexural strength, 73 F, psi	ASTM-D790-49T	Shall not break
Flexural modulus, 73 F, psi	ASTM-D790-49T	400000 min
Hardness, durometer	ASTM-D676-49T	65
Coeff. of expansion, avg 0 to 350 F, diameter, in. per in. per deg F	—	30×10^{-6}
width, in. per in. per deg F	—	90×10^{-6}
Density, lb per cu in	—	0.080 min
Flammability	ASTM-D635-44	Nonflammable
Color	—	Yellow-green

Table 4 Wear Tests, K-30 Vs. Various Cylinder Materials

Wear test drum material	Wear, milligrams, weight loss one hour, room temperature — K-30 rider	Drum
Cast iron	1.6	0.3
316 Grade stainless steel	2.8	0.8
410 Grade stainless steel	2.0	0.6
Nitrided 4140 steel	2.4	1.8
Dense chromium plate	13.9	7.1
AMS 7322A bronze	1.1	24.1
319 Aluminum alloy	24.5	22.3
M377 Aluminum alloy	51.9	23.2

Wear Tests Using Different Drum Materials

Piston rings and wear rings have to be compatible with many different cylinder materials. K-30 was wear-tested against drums of different materials, at room temperature, with 5-lb load for 1 hr at a constant drum-

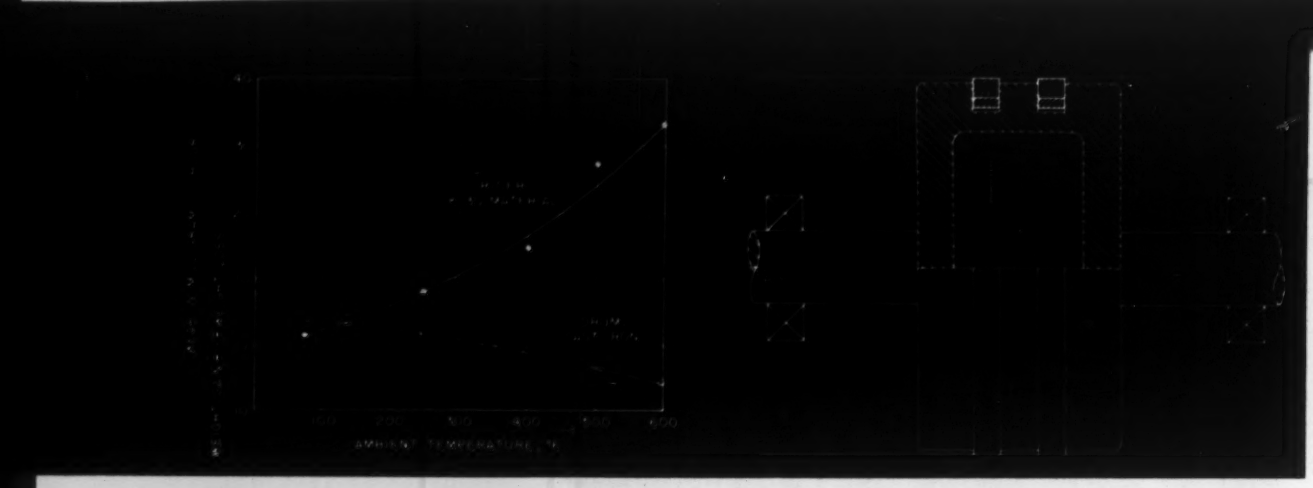

Fig. 1 The effect of wear versus temperature with K-30 riders run against cast-iron drums for 1 hr

Fig. 2 Typical piston-ring arrangement for nonlubricated compressor with tail-rod support

surface speed of 1600 fpm. Table 4 shows the results of these tests. Less wear was experienced with cast-iron or stainless-steel drums than with dense chromium-plated drums. The reason for this higher wear is not understood fully, but it would appear that the expense of chromium-plating cylinders could be eliminated by the use of piston rings and wear rings made of K-30 material. The wear obtained when running K-30 against the aluminum-alloy drums appears high, but K-30 is one of the few materials tested which would wear directly against aluminum without complete surface destruction.

Fortunately, bronze is not often used as a cylinder material as rather high drum wear occurred with this material even though the K-30 rider wear was low with this combination.

Effect of Ambient Temperature on Wear

A series of wear tests was conducted to determine the effects of temperature on wear. Riders of K-30 material were run against cast-iron drums for 1 hr, with a 5-lb load and 1600-fpm surface speed at temperatures up to 600 F. A new rider and drum were used for each test at the temperature tested. The results are shown in Fig. 1. The amount of rider wear increased with increase in temperature while the drums tended to gain weight, from a deposit of Teflon on the surface. It was somewhat surprising to find that the K-30 rider at 600 F carried the load and operated so close to the Teflon jell point of 620 F.

Table 5 Typical Nonlubricated Compressor Applications

Type compressor	Bore size	Medium	Pressure psig Inlet	Pressure psig Outlet	Temp, F	Average piston speed, ft/min
Single-stage, double acting, horizontal	4 7/8	Dry nitrogen	70	225	140	455
Two-stage, Y-type double acting	8 1/2	Air	25	85	290	685
Multi-stage, double acting high-pressure cyl	4 3/8	Hydrogen & ammonia	4,700	5,000	130	160
Single-stage, double acting, vertical	9	Air	15	110	460	400
Multi-stage, double acting, horizontal	1 1/2	Air		2,400	350	467
Double acting, horizontal	11	Ammonia	2,750	3,150	125	360
Multi-stage, double acting	5 1/4	Carbon dioxide	280	1,250	300	640
Two-stage, double acting, horizontal	14	Hydrocarbons	4	112	290	—
Multi-stage, high-pressure cylinder	3/4	Wet hydrogen	1500	4500	212	204

Types of Compressors

Nonlubricated gas and chemical-process compressors vary in design, but generally the piston is driven through a crosshead from the crankshaft. By using a crosshead drive, the compressor cylinder can be completely isolated from the crankcase, thus eliminating any possible oil entry into the cylinder. This type of drive also prevents side-thrust effects on the piston from the crank action.

Cylinders may be horizontal, vertical, or "V" position, and there may be one or more stages. The compressor stages may be single acting or double acting. Operating speed, pressures, temperatures, and mediums vary over a wide range as illustrated by some typical applications shown in Table 5.

To prevent metal-to-metal contact between the piston and cylinders, the piston may be supported by means of a tailrod or wear rings. Fig. 2 shows how a piston is supported by a tailrod. This type of piston requires only piston rings to seal the piston. The tailrod must be properly aligned, however, to prevent the piston from touching the cylinder.

Wear rings are used on the piston in other types of compressors to prevent rubbing. Piston rings are also used for sealing. Fig. 3 shows a typical piston with wear rings and piston rings.

Types of Piston Rings and Wear Rings

Experience gained through actual tests in nonlubricated compressors indicated that the two-piece sealing-ring design is ideal for the use of K-30 ring material. It consists of a step-joint outer ring, and a straight-cut-joint inner ring. This basic design has also achieved broad industry acceptance.

For nonlubricated applications, this design incorporates an outer ring made of K-30 material which is compatible with all cylinder materials, and a metallic inner ring to provide the necessary tension. Depending upon the medium to be compressed, the inner ring may be cast iron, bronze, or stainless steel.

Wear rings of K-30 material may be solid, one-piece split, or segmental type depending upon piston construction. As these wear rings carry part of the piston weight, and in effect control the wear life, they are usually wider than the piston rings.

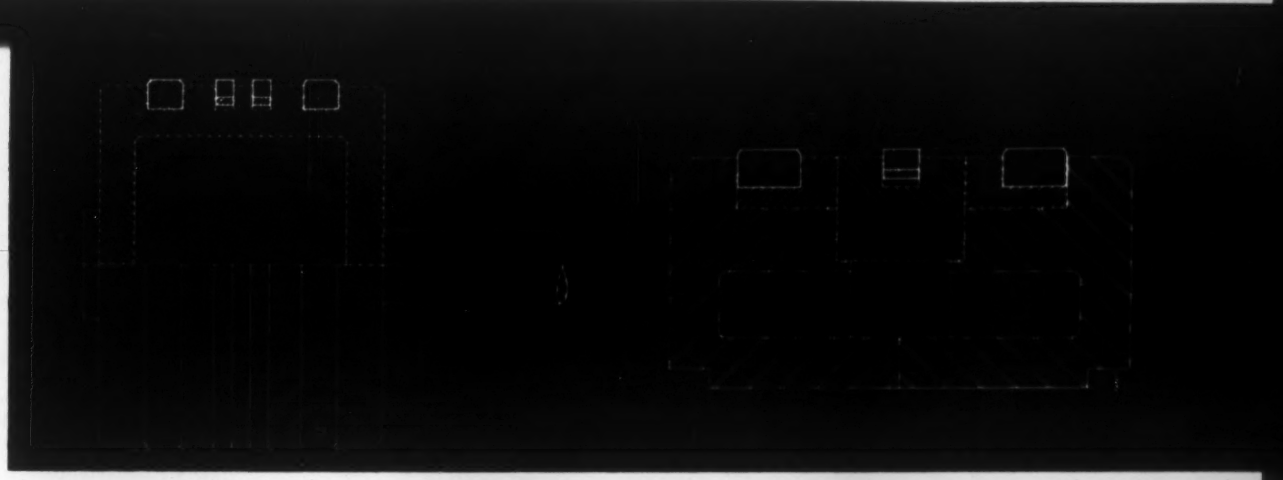

Fig. 3 Typical wear and piston-ring arrangement for nonlubricated compressor with wear-ring support

Fig. 4 Piston ring modified to use K-30 rings by the use of filler rings

Piston Ring and Wear Ring Design

In the design of piston rings and wear rings, the high coefficient of thermal expansion of K-30 must be considered. In determining proper clearances, the differential expansion between the ring and the cylinder, and the ring and the piston are calculated. It is important to know the type of cylinder and piston material as well as the operating temperature.

In general, the K-30 piston rings and wear rings are designed to fit existing piston grooves in order to be interchangeable with the previous type rings. The existing groove depths may be such that excessive back clearance occurs behind the piston rings. This condition should be avoided as inner-ring breakage is likely to occur. If a new piston, with the proper groove sizes cannot be used, filler rings may be used in the bottom of the piston-ring groove. Filler rings also are helpful in reducing the size of the wear-ring grooves. Fig. 4 illustrates a design which reduces the groove sizes.

Service Tests

Through the co-operation of manufacturers and operators rapid progress has been made on actual service tests. Interest in these tests has been high, and usually each company had a "tough" application on which to try K-30 rings. Service in these applications proves the merit of K-30 material for use in piston rings and wear rings.

A number of applications are described and the performance given in the following section. Many others are still in progress and wear data have not yet been obtained on them.

Miscellaneous Applications

Hydraulic and pneumatic actuators operating under hot and poorly lubricated conditions offer many possibilities for K-30 sealing rings. The compatibility of this material with aluminum alloys used for cylinder materials is a distinct advantage.

Certain types of thrust bearing and wear bushings may be made in the K-30 material permitting the reduction or elimination of lubrication.

In some cases, it has been possible to convert existing lubricated-type compressors to operate without cylinder lubrication. By modifying the piston or the use of a new piston, K-30 wear rings and piston rings may be used. The advantage in such a conversion, for example in a compressor supplying instrument air, is manifold. The cost of the lubricant is saved, plus the fact that there is no oil to remove from the air which eventually fouls up the instrument and air lines. In addition, danger of explosions and fire is avoided as no oil is present in the cylinder.

Conclusions

K-30 material based on Teflon has been found to have self-lubricating properties which will permit operation in many applications without lubrication.

A thorough knowledge of the properties of this type material is essential to design piston rings and wear rings for each application. Machining and special manufacturing methods were developed for handling the material to produce high-quality rings.

By utilizing to the best advantage the properties of K-30 material, piston-ring and wear-ring sizes may be reduced, simplifying piston construction and reducing length and weight.

This investigation indicates that there is a definite place in the nonlubricated field for K-30 material.

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bearings, lubricants, and lubrication

journal bearings

A PAPER by Raimondi and Boyd (1)[1] presents a portion of a comprehensive study aimed at facilitating analysis and design of journal bearings. Its charts and tables eliminate the need for side-flow factors. It is based on a numerical solution (obtained on a digital computer) of the Reynolds equation for the journal bearing. Charts in this paper cover bearing arcs of 60, 120, 180, and 360 deg for a length-to-diameter ratio of unity. Part II (2) extends the work of Part I to the case of length-to-diameter ratios of 1/2 and 1/4.

Properties of misaligned journal bearings under hydrodynamic conditions of lubrication are presented by DuBois and Ocvirk (3) from experimental data. Curves in dimensionless form give journal-bearing attitude as a function of the usual bearing variables and the couples which produce misalignment. Examples show the application of dimensionless curves to typical problems of misaligned bearings.

Performances of plain bearings under steady central loading are compared and summarized by single line curves by DuBois, Ocvirk, and Wehe (4). Experimental data on eccentricity ratio, friction, and oil flow are shown for length-diameter ratios of 1/4, 1/2, and 1.

Shawki and Freeman (5) describe a testing machine to investigate the performance of a complete journal bearing under the action of a vertical load consisting of a sinusoidal variation superimposed on a steady component. The ratio of the frequency of the load oscillation to the journal rotational frequency is a critical factor. Pinkus (6) solved the Reynolds equation (on a digital computer) for bearing operation in which the load vector is located at any arbitrary position with respect to the two diametrically opposite oil grooves of a finite full journal bearing.

Treating viscosity as a function of temperature and pressure, the problem of the journal bearing without side flow is solved by Hughes and Osterle (7) for the case of adiabatic flow of the lubricant subject to the Reynolds boundary condition. Dizioglu (8) presents a study of viscosity, friction, and temperature relations in high-speed bearings. Coefficient of friction is shown to depend not only on the Sommerfeld number but also on a number related to the thermal behavior of the bearing surfaces. Kreisle (9) reports an investigation which developed a criterion for predicting the conditions under which full-film lubrication will change to "marginal" lubrication.

Cole and Hughes (10) have a method for photographing oil films in glass bearings of clearance ratio 0.001 and 0.002. Results are given for film extent and oil flow. A visual study of bearing operation under fluctuating loads and an incomplete film is described by Ozdas (11). Tichvinsky (12) gives results of the measurement of starting bearing friction torques. Theoretical studies of lubricant inertia in slider and journal bearings have been made by Saibel (13).

Wildmann (14) experimented on gas-lubricated journal bearings. Variations in speed, ambient pressure, gas, and load were tried for their effect on deflection and attitude angle. Film pressure distributions were obtained. A theory propounded by Ausman (15) claims that the pressure-density relationship in gas-lubricated journal bearings is the reversible adiabatic one despite irreversible viscous shear and heat conduction.

Bearing Test Machines. Bearing test machines with dynamic loading or nonuniform motion are described and classified by Hersey and Snapp (16). Over thirty such machines have been disclosed in the published literature. The authors have endeavored to find answers to six questions concerning each machine: (*a*) its loading mechanism, (*b*) test bearing details, (*c*) range of variables, (*d*) performance criteria, (*e*) characteristic limitations or advantages, and (*f*) extent of use. In a companion

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Report prepared by H. A. Hartung with the assistance of the Research Technical Committee of the ASME Lubrication Division. Contributors were E. Saibel, F. Osterle, D. W. Dudley, B. T. Ruley, S. J. Beaubien, N. H. G. Daniels, and H. A. Hartung. The summary for the year 1956 was based principally on the Engineering Index references on Bearings and Lubrication.

The "Digest of 1955 Literature" appeared in MECHANICAL ENGINEERING, vol. 78, August, 1956, pp. 703–714.

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

paper (17), the same authors describe an engine-bearing test machine consisting of a motor-driven modification of a commercially available diesel engine. The machine was developed primarily for endurance testing of engine-bearing materials and design. A rating system is described for evaluating various failure elements so that bearings may be compared without testing them to destruction. Test results and the use of an oil-film-thickness indicator are described.

Pigott and Walsh (18) report their work on bearing testing machines directed toward improving precision and sensitivity, and outline the steps leading to the development of a rotating-load bearing test machine.

Bearing Materials. Kretzschmar (19) reports investigations of metal-sprayed babbitt bearings of steel or cast-iron base with surfaces of sprayed coatings of bronze, copper-graphite mixtures, brass, zinc, and aluminum alloys. Tests to determine strength and wear resistance are described. Main advantage of these bearings is the conservation of scarce nonferrous metals.

The success of composition bearings (sometimes referred to as phenolic resin, fabric, or plastic bearings) as roll neck bearings in steel mills, requiring only water as a lubricant, is noted by McHenry (20). Types of compositions, their physical properties, and operating characteristics are discussed. Cheney, Happoldt, and Swayne (21) list the frictional properties of nylon and tetrafluoroethylene resin. Typical data on dry or partially lubricated bearings are collected, and the effects of wall thickness and clearance are discussed. A new water lubricated bearing developed for service in water at temperatures of 200 F and over is described by Nudelman, Sump, and Troy (22).

Practical Applications. As a practical example of lubrication theory, problems of bearings on large gas engines are considered by Garski (23). Damage is found to result from failure to observe the laws of hydrodynamic theory in design. Bearings designed properly showed small wear. Newman (24) discusses design in relation to reliability and efficiency of turbine and gear bearings, advantages of high-tin white metal, and the relative merits of nonferrous and ferrous shell materials.

Determination of maximum safe operating speed must take into account bearing eccentricity ratio, minimum oil-film thickness, and magnitude of bearing reactions as well as critical speed as determined from the elastic properties of the system according to Maday (25). Factors influencing design and lubrication are analyzed by Fuller (26), with design recommendations and a method for determining minimum oil-film thickness.

Special Topics. Lewicki (27) makes an analysis of parallel sliding, allowing for the behavior of the lubricant in the free space (flooded to infinity) in front of the square-faced slider by an approximate solution of the Navier-Stokes equations. The author claims it is the pressure build-up in this region that accounts for the load-carrying capacity of parallel sliders and not, as is currently thought, the thermal wedge effect. The parallel surface thrust bearing is considered by Zienkiewicz (28) with temperature change both along and across the film.

Considering grease as a Bingham plastic, Osterle, Charnes, and Saibel (29) solve the problem of the load supported by a squeeze film where side flow is neglected, with grease as the lubricant. This load is found to exceed the load which would be supported by a Newtonian fluid with the same mobility.

Pinkus (30) discusses bearings in which the clearance space is intentionally not uniform. He includes expressions for power losses as a function of the customary bearing parameters and defines a new variable, ellipticity. The analysis assumes full oil film and allows for incomplete oil film in the diverging portions of the bearing.

Various bearing designs and bearing materials have been evaluated and reported by Smaardyk (31) for use in water-cooled nuclear power plants. Test facilities are described. Data are given on corrosion resistance and wear characteristics of most promising water-lubricated bearing designs and material combinations for operation in high purity water at temperatures from 200 F to 500 F.

Barwell (32) discusses the use and abuse of the Sommerfeld number. He proposes separating it into a hydrodynamic component and into a geometric factor which will take into account the width of the bearing.

thrust bearings

A simplified model is constructed by Hughes and Osterle (33) and solved for the effect of heat transfer from the lubricant to the bearing on the load capacity; the treatment considers hydrostatic thrust bearings using either air or oil as the lubricant. The bearing performance proves essentially isothermal at an elevated temperature which can be readily computed.

An experiment in the operation of tilting-pad thrust bearings is described by Kettleborough, Dudley, and Baildon (34). The following determinations were made: film pressure distribution, film geometry, friction characteristics, and temperature distributions for a range of speeds, loads, operating temperatures, and pivot positions. A correlation with theory is presented.

Kettleborough (35) makes an analysis of stepped thrust bearings by means of an electrolytic tank, and the load capacity proves greater than for the tilting-pad bearing. By a suitable choice of the operating variables it is possible to design a stepped-pad thrust bearing which will operate over a wide range of loads with greater film thickness and a lower coefficient of friction than a tilting-pad thrust bearing. In another study, Kettleborough

(36) shows that the maximum load that can be supported by a tapered-land thrust bearing is about 14 per cent greater than the maximum load supported by the stepped-pad bearing which in turn can support only slightly more than the tilting-pad bearing, all cases not neglecting side flow. The superiority of the tapered-land bearing over the stepped-pad bearing, with side flow considered, is explained.

Finally, Kettleborough (37) applies Boegli's simplifying assumption for the solution of the rectangular pad to the sector-shaped pad, and carries it to the case of varying viscosity. The process of obtaining the operating characteristics is rapid, and yields results comparable with longer numerical methods.

The problem of the grease-lubricated thrust bearing is solved by Slibar and Paslay (38) with a perturbation procedure using the Hencky-von Mises-Huber yield criterion. Curves are given, for design, which can be used directly to predict the properties of a thrust bearing.

Sternlicht and Sneck (39) give a numerical solution (obtained on an IBM-650 digital computer) of Reynolds equation for sector thrust bearings. Several film geometries are analyzed; numerical results are presented, and compared with analytical solutions. Ying, Charnes, and Saibel (40) propose an exact solution for Reynolds equation in the hydrodynamic theory of slider-bearing lubrication, taking side leakage into account. The film thickness is assumed to vary exponentially in the direction of motion, symmetrically in the perpendicular direction.

Instead of the Reynolds equation, the Navier-Stokes equations are used by Milne (41), without inertia terms, to derive the equations of hydrodynamic lubrication. For a slider bearing having no side leakage this gives solutions which agree with the conventional treatment for small angles of inclination, but for angles above 30 deg the Reynolds approximation is found inadequate.

gears

In gear lubrication, theory and research continued to probe things that have puzzled gear engineers. The exact mechanisms of gear pitting and gear wear are still subject to question by many gear specialists. In even greater doubt is the relation—or lack of relation—between abrasive wear of gear-tooth profiles and pitting. Another question in the gear field is the nature of the lubrication between contacting gear teeth, whether gear teeth have hydrodynamic lubrication or boundary lubrication—or a combination of the two.

Lewicki (42) claims he has been able to verify that an oil-film thickness in the order of 10^{-4} cm was present in a special test rig that loaded two hard brass rolls against each other to simulate gear-tooth action. He presents a mathematical analysis of his lubrication theory, and then presents full details of his test setup and the problems involved in measuring film thickness. He feels that his hydroelectric theory of lubrication is verified and that he has discovered new phenomena about effective film viscosity.

Tourret (43) shows test data on worm gear units to relate oil viscosity, load, speed, and temperature. Equilibrium temperatures reached under different conditions indicate that a high-viscosity oil shows more friction loss at light load than a low-viscosity oil. However, at high load, the high-viscosity oil showed less loss than the low-viscosity oil. This fact suggests that the high-viscosity oil was able to separate the rubbing surfaces even under heavy load. Wear tests on a bronze disk reported by Tourret show a tendency toward decreased wear with increased viscosity. His theory and experimental data indicate that the friction on the surface is a prime cause of both wear and pitting.

Shipley (44) analyzes scoring, wear, and pitting of gears. Test data show how changes in oil viscosity permit a very appreciable upward shift to the S-N curve as oil viscosity increases. Scoring-test data are analyzed by the PVT and flash-temperature formulas. Logical correlation of variables is obtained by the flash temperature formula. Radioactive wear tests are described. Peculiar transitory wear effects are noted. It would not have been possible to have detected these effects in conventional gear endurance tests. Kyropoulos (45) summarizes the concepts of how an oil lubricates gears, explaining such things as boundary layers, polar molecules, EP additives, and greases.

Although there was not a great amount of published material on gear lubrication, committee activity within the American Gear Manufacturers Association revealed that extensive private-industry and government-sponsored research work was being done. In particular, the new field of gear lubrication in the 400 to 700-F range for high Mach number airplanes is receiving serious attention. Published data should appear shortly.

rolling element bearings

Research on rolling bearings during the year continued to be concentrated primarily on operation in high-speed, high-temperature applications such as aircraft gas turbines where lubrication conditions are severe and reliability is critical.

Lewicki (46) developed a theory concerning the action of lubricant in roller bearings and gears and gave experimental confirmations of this theory His conclusions serve as a possible explanation for some test phenomena in bearings, but have not been reconciled to other phenomena. Barnes and Ryder (47, 48) emphasize the importance of obtaining a known minimum life in aircraft gas-turbine bearings, and discuss a machine for the rapid fatigue test of balls rolling under load. Test

results run on this machine rate the materials SAE 52100, MV-1, and vacuum-melted 52100 in ascending order of life, in good agreement with test results on complete bearings.

Barwell and Scott (49) use a four-ball test rig to evaluate the lubricating qualities of petroleum lubricants versus flame-resistant hydraulic fluids. The results show a very low life for bearings lubricated with flame-resistant fluids, with the formation of surface cracks prior to pitting failure, possibly due to increased shear stress at the contacting surfaces. Field tests in pumps are reported to confirm qualitatively the results obtained in the specimen tests.

Morrison (50) reviews the appearance and causes of unusual types of bearing failure, and reports tests on the influence of lubricants on life under vibratory and oscillatory conditions. A lithium-base grease with added molybdenum disulfide gave the best average life of the greases tested in aircraft control rod bearings. Tests were run with rotating bearings and synthetic hydraulic fluids. The lives obtained with hydraulic fluids seem roughly comparable to the low lives obtained with low-viscosity fluids generally.

Cordiano, Cochran, and Wolfe (51, 52) report tests on combustion-resistant hydraulic fluids as bearing lubricants under both high and moderate load conditions. They report that, in order to obtain a bearing life equal to that obtained with petroleum lubricants, the bearing capacity must be multiplied by 2.6 for a water-glycol-base fluid, 1.5 for a phosphate-ester-base fluid and 1.2 for a phosphate-ester fluid.

Nemeth and Anderson (53) tested bearings operating at temperatures up to 850 F with grade 1010 oil. Satisfactory performance was obtained when the oil flow rate exceeded the combined oxidation, evaporation, and decomposition rates. Moore and Jones (54) reported on the frictional torque of high-speed ball bearings at high oil flow rates. The speeds reported ranged up to $1.7 \times 10^6\ Dn$ (D is the bore in mm, and n is the speed in rpm).

Sorem and Cattaneo (55) studied the operation of bearings at high temperatures in the absence of a lubricant. If operated completely dry, oxidation and oxide-induced abrasion were the principal causes of wear. A reducing atmosphere, air and hydrocarbon vapor, eliminated oxidation and reduced abrasion so that separator scuffing became the limiting factor in bearing life. Bearing pretreatment, with extreme pressure elements such as sulfur, improved scuffing resistance.

Markert and Ferguson (56) report tests of ball bearings with low-viscosity liquid-metal lubricants. Primary source of failure was separator wear and the transfer of separator material to the rolling elements. Fatigue failure cracks then started from the surface of the raceways or balls and moved inward in the direction of rolling. A nonmetallic separator gave superior life in the range where temperature permitted its use (i.e., up to about 300 F). Preston, Mogul, and Floroff (57) review the various ball and ring materials used in bearings for aircraft power plants. They recommend the use of improved inspection techniques to insure steel low in nonmetallic inclusions.

Wagner and Burwell (58) studied wear behavior of separator materials up to temperatures of 800 F. The materials were tested against rotating tool steel disks and evaluated on the basis of (*a*) their wear rate as a function of temperature, (*b*) their tendency to cause vibration in the test machine, and (*c*) the extent of metal transfer to and scoring of the tool steel disk.

Fogg and Webber (59) report on friction tests carried out on ball and roller bearings during World War II. With ball bearings of the deep-groove type, tests were run under a large variety of load, speed, and internal tolerance conditions. Speed had little effect on torque. The diametral clearance was shown to have an appreciable effect on running temperature, the greater diametral clearance running cooler within the limits tested. Tests were run varying the load angle but holding the sum of the radial and thrust loads constant. Also tested were various separator pocket shapes and clearances, with indications that sufficient axial clearance in the ball pocket is the most important factor. Roller bearings under radial load led to similar conclusions regarding bearing torque, with the additional fact that cageless, cylindrical roller bearings had less torque at very high speeds than those with separators.

Barwell and Hughes (60) continued the work of Fogg and Webber with large ball bearings. They found that friction torque decreases slightly at higher speeds; the operating temperature depends more on speed than on load. Most of the friction torque measured was due to viscous friction in the lubricant. The afore-mentioned two papers, with comments, constitute a review of recent work in ball-bearing theory.

Tabor (61) reviews work reported earlier on the measurement of elastic hysteresis loss or damping in rolling contact. He reviews earlier theories of rolling friction and concludes that, provided mating curvatures are not too close, elastic hysteresis is the primary cause of rolling friction (in the absence of high speed and turbulent viscous lubricant).

Lieblein and Zelen (62) analyze test results submitted by several ball-bearing manufacturers and conclude that, for the test conditions, fatigue endurance life varies inversely with the cube of the load. This analysis is an example of the application of modern statistical techniques to component fatigue testing.

boundary lubrication

Physical methods applied to lubrication research have been described by Barwell and coauthors (63) at the 4th World Petroleum Congress. Electron microscopy, electrical-resistance measurements between surfaces in contact, and film-thickness measurement are discussed.

Greater attention has been given during 1956 to the study of junctions in the friction process. Greenwood and Tabor (64) studied shearing of large-scale models of junctions with strong adhesion, weak adhesion, and lubricated sliding. Their results agree qualitatively with earlier theoretical solutions based on the theory of plasticity (Green) and suggest that, for lubricated junctions, plastic deformation contributes an appreciable part of the friction. Ling and Saibel (65) analyze the friction produced by weld junctions of unlubricated metals by applying reaction rate theory. Spurr (66)

studied the variation of the coefficient of static friction μ, between a soft hemisphere (indium and zinc) and a glass surface. The same author (67) also develops simple expressions for the ploughing contribution to friction when a brass, aluminum, or copper surface slides over a hard steel ball or wedge.

Rabinowicz (68) uses a simple model of sliding friction, and through autocorrelation analysis, using an artificially obtained friction trace, he deduces the average size of the junctions. He suggests that, with assumptions as to the shape of the force-displacement curve of the junctions, information on size distributions can be obtained.

Rabinowicz (69) also derives an expression for the relationship between friction and total mechanical wear. The argument is supported by experiments with slow speed sliders on flat surfaces which show the relation of friction to the degree of metal transfer and the amount of loose wear fragments. The derived equation demonstrates how small changes in friction can produce large changes in wear, and how two lubricants with the same μ may permit large differences in the rate of wear. In a third paper (70), the same author gives a mathematical treatment for the two cases of the distribution of transfer fragments, depending on whether they are tightly or loosely held. Rightmire (71) formulates an expression for metal transfer from the statistical behavior of contacts, and obtains estimates for the probability of removing transferred metal by subsequent contacts.

From a study of unlubricated wear over a range of loads and speeds, Archard and Hirst (72) conclude that, for nearly all cases, wear rate is independent of the apparent area of contact and, for the majority of combinations, is approximately proportional to the applied load. Kerridge and Lancaster (73) made a detailed study of a severe type of wear using brass pins rubbing against stellite or tool steel under conditions which gave metallic debris. From determinations of total wear and radioactive measurements of metal transfer, they conclude that severe wear always occurs via a layer of transferred metal, and that there is no direct production of loose particles.

The nature of surface films between metals sliding at low speeds was studied by Wilson (74). At very light loads sliding may occur without disruption of the oxide film; at heavier loads, depending on the hardness of the underlying metal, the film ruptures, leading to metal-to-metal contact. Experiments with stearic acid indicated that boundary lubricants did not prevent the close approach of metal surfaces except at very light loads; however, even at high loads the friction was low.

Surface films and their relation to friction, wear, and surface damage are discussed by Bisson, Johnson, Swikert, and Godfrey (75) in a report on their extensive researches which includes numerous references to other work in the field. Naturally occurring films on some materials, such as graphitic carbon on cast iron and NiO on nickel alloys, prevent surface damage and wear in some cases. Lacquers from petroleum and synthetic lubricant decomposition are discussed. Information on the use, limitations, and effectiveness of MoS_2 is also given, including methods of bonding, and high-temperature effects.

Johnson and Vaughn (76) believe that, whereas graphite lubrication depends on the presence of an adsorbed film of water on the graphite surface, MoS_2 provides its own adsorbed layer of sulfur formed during a run-in period. Hirst and Lancaster (77) studied brass and aluminum sliding on stellite for both dry and lubricated systems. A rapid increase in wear and a great change in the size of wear particles were found when a critical load was reached; this transition load was associated with the breakdown of a protective surface film which was generated during sliding and was not present originally.

The effect of temperature on boundary lubrication has been further explored. Coffin (78) evaluates friction and surface damage for couples made of metals completely soluble in each other, and studies effects of temperature, and gaseous and liquid environments. Friction, metal transfer, and wear are found to increase sharply above a critical temperature, which depends on the lubricating quality of the environment, the metal composition, and the sliding velocity. A mechanism based on surface diffusion is proposed to explain the results. Cowley, Ultee, and West (79) study lubrication as a function of bulk oil temperature, and they too find critical temperatures where smooth sliding ceases and seizure begins. Their results are discussed in terms of chemical and physical adsorption.

Scoring characteristics of various metals against steel during high-speed sliding have been investigated by Roach, Goodzeit, and Hunnicut (80). Best metals were the B-subgroup metals which are either insoluble in iron or form intermetallic compounds with iron.

Metal oxides as lubricants at high temperatures were evaluated by Peterson and Johnson (81), who found PbO the best oxide, giving μ of 0.09 above 900 F. Friction and wear for chlorinated methylphenyl silicones at temperatures up to 600 F were determined by Bowers, Cottington, Thomas, and Zisman (82). The same authors in another paper (83) investigate boundary lubrication and wear properties of fluorinated diesters and bis (2-ethylhexyl) sebacate at temperatures up to 400 F. The effects of antiwear, antioxidant, and oiliness agents compounded with each diester were also studied. Crump (84) studies the durability and μ for films containing MoS_2 and graphite and concludes that film life decreases with increasing load and increases with film hardness, underlying metal hardness, and speed. Savage and Schaefer (85) study the wear of graphite sliding on copper, using small amounts of vapor from organic compounds as the lubricant. The lamellar structure of the dihalides of titanium and zirconium prompted Rowe (86) to include experiments with iodine and chlorine in a study of the vapor lubrication of these two metals.

Sternlicht and Apkarian (87) studied wear and energy dissipation at the interface of contacts carrying up to 600,000 amp/sq in., and sliding at up to 2000 fps. Under certain conditions the external load is partially supported hydrodynamically through a molten layer at the interface. Some experiments by Niven (88) on friction of various plastics on ice at -5 C and -15 C provide information additional to, and in some cases at variance with, the ski experiments of Bowden. Friction is found not to be proportional to load, deviations from Amonton's law being evident at high speeds.

Metal Forming The relation between the frictional conditions in metal forming and the properties of the worked material has received little detailed study. Hundy and Singer (89), in a study of inhomogeneities in rolled sheet and drawn wire, include experiments which show that variations in hardness produced through the thickness of rolled copper sheet become less as the friction between the sheet and the rolls is reduced. Savitski and Zagrebemnikova (90) show that the microhardness of surfaces subjected to friction is independent of prior compression and greater than the microhardness produced by compression alone.

Examples of inefficient practices in wire drawing are given by Tourret (91) together with a brief account of factors affecting the lubrication of aluminum and copper-wire drawing. Wax lubricants, particularly for aluminum-wire drawing, are evaluated by Werner (92), while Weaver (93) discusses the application of colloidal graphite in wire drawing.

In part III of a series of papers by H. Majors (94) on cold drawing of SAE 1020 steel and 2S-O aluminum rod, the average μ for forward and reverse drawing is obtained by the measurement of radial pressures around the die with electric resistance strain gages. High-temperature extrusion of steel by the Sejournet process, using glass as a lubricant, has been described by the inventor and Delcroix (95) who develop an equation for calculation of extrusion pressure. Munro (96) reports on colloidal dispersions of glass in alcohol to reduce oxidation in heating and to provide lubrication during hot working of metals.

Studies of the variables governing friction in cold rolling are reported by Whitton (97) in a sequel to a previous article (reference 97, 1955 Digest). This author remarks that the best surface finish is obtained with lubricants giving an intermediate value of μ, and seems to vary with the lubricant rather than the numerical value of μ (cf. reference 96, 1955 Digest). Billigman (98), who considers that boundary lubrication is the operating state in cold rolling, compares various oils and emulsions on the basis of an arbitrary "lubrication index" (palm oil = 100; water = 0) in terms of the strip thickness produced with fixed mill settings.

An account by Johnson (99) of theoretical and experimental investigations into metal-forming operations at Sheffield University, England, includes a section on lubrication of cup drawing. The author discusses the existence of a speed effect with certain lubricants, and the increase in critical blank diameter which can be obtained with good lubrication, such as that of a graphite-tallow mixture. A note on testing the efficiency of lubricants for deep drawing of nonferrous metals is included in a review of established and modern techniques by Grainger (100). Results of adding molybdenum disulfide to various media are summarized in a diagram of drawing pressure plotted against blank-holding pressure. A practical account of lubrication in deep drawing is given in three parts by Viers (101). There is a statement of the ten essentials of a good drawing lubricant and examples of complicated and difficult draws which can be successful with good lubrication.

Bastian (102) classifies materials used in drawing lubricants into polar compounds, polishing agents, and EP agents, which are frequently blended to provide a wide range of compounds. A discussion of types of compounds for use with various materials is followed by a list of requirements of a good drawing compound. A method of deep drawing involving use of a rubber pad between the punch and the blank is described by Maslemikov (103), who gives formulas for castor-oil-colophony lubricant compositions suitable for this operation.

In the field of newer materials the forming of titanium and titanium alloys presents a problem, and a report of practical experience, including lubricant recommendations, has been prepared by Achbach (104). Silicones for both metal-forming and metal-cutting operations have also been briefly reviewed (105).

Metal Cutting. Metal-cutting research has brought many new techniques to the field, and several of these are described in review by Bacher and Krabacher (106). Radioactive tracer methods for the measurement of tool wear, tool-chip interface temperature measurement, and high-speed microphotography are three of the techniques discussed. Another review including experimental results by Galloway (107) analyzes the factors involved in the machinability of nonferrous materials.

Rall and Giedt (108), using buried thermocouples in the tool tip, show that temperatures up to 1400 F can occur at the tool-work contact in the dry orthogonal cutting of SAE 1020 steel. Reaction rate theory is applied by Trigger and Chao (109) to correlate tool top-face wear with tool-chip interface temperature, while Ling and Saibel (110), viewing tool failure as essentially a rupture process, use a similar attack to interpret tool life-cutting temperature data.

In a study of the friction between chip and tool, Finnie and Shaw (111) show how deviations of the friction relationships from the classical laws of sliding friction can be explained in terms of the high value of the real-area/apparent-area-of-contact ratio, caused principally by the high normal pressures between the chip and the tool.

The flash surface temperature in grinding, while difficult to interpret precisely, seems related to surface damage and wheel wear. Mayer and Shaw (112) measured a temperature, θ_c, which is the mean of a partly ground and partly unground area, by using a lead sulfide cell sighted through a small hole in the grinding wheel. Grinding oils gave only slightly lower temperatures than water-base fluids, the better lubricating action of the oils being offset by their lower cooling capacity.

Two papers have been concerned with fluids for the grinding of titanium which often causes rapid wear of the grinding wheel. Shaw and Yang (113) carried out a systematic study of aqueous solutions of inorganic salts, such as sodium nitrite, on the basis of the grinding index G (= volume of metal removed/volume of wheel consumed). In a second paper on this subject, Krabacher (114) emphasizes the necessity of reducing the tendency of titanium to weld to refractories, with many of which titanium will react at high temperatures. This investigator used a simple screening test for titanium grinding fluids. When a sharp edge of titanium is drawn over a glass surface, a streak is left; a potentially useful fluid will prevent this.

In a study of flood and mist coolant application, Shaw and Smith (115) conclude that in carbide tool turning of 4140 steel the major role of a cutting fluid above speeds of 200 fpm is cooling. At 250 fpm, water-base fluids

were slightly better than plain water, due to the slight boundary lubricating action; but at 400 fpm, where the action is entirely cooling, water was as good as any fluid in reducing tool wear.

The surface quality of a reamed hole in an alloy steel depends, according to G. S. Andreev (116), primarily on the load-carrying capacity of the cutting oil, as measured in a sliding friction machine. For deep holes, or for special materials such as austenitic stainless steels, additional factors (for example, swarf removal or cooling) become important. Fleming and Sudholz (117) consider comparing the torque required in a tapping test a good way of evaluating cutting fluids. Among other advantages, it is economical, yet correlates well with field results.

Dorinson (118) investigates the effect of various additive concentrations on cutting oils by tests which included turning, planing, and tapping. He suggests that the behavior of a cutting oil depends on the net effects of temperature-dependent interdiffusion at asperities between metal and tool, which results in wear, and the temperature-activated reaction of the metal with the additive, which can also cause attrition of the tool.

The dual function of a cutting fluid in both cooling and lubricating the chip-tool interface, and the improvements made in modern fluids of both types are described by Gould and Givens (119). Claims for improvements in tool life obtained by the use of liquid carbon dioxide (120), and a proprietary cutting fluid (121) are also to be found in the metal-cutting literature.

automotive lubricants

Deposits. Spindt, Wolfe, and Stevens (122) note that nitrogen is normally present in engine deposits, usually as an aliphatic nitro compound. They reason that nitrogen oxides are formed in the combustion chamber, and that these oxides react with fuel components to form organic nitro compounds. In tests of low oxide formation in the combustion chamber (low air-fuel ratio), piston varnish was low; it increased when the air-fuel ratio was raised. When nitrogen dioxide was added to the intake or crankcase, piston deposits rose markedly; running with an artificial atmosphere in which carbon dioxide replaced nitrogen, the deposits decreased substantially.

Wear. In laboratory tests on multicylinder engines, Pocock (123) found detergent oils capable of carrying abrasive particles through the lubricating oil system. He shows that with coarser filters in a contaminated oil system, more wear occurs; further, use of detergent oil may make it more difficult to remove the abrasive particles.

Single-cylinder engine tests by Popovich and Johnson (124) show piston-ring wear influenced by oil viscosity. An SAE-5 oil gave very high wear rates; as oil viscosity was increased, wear rate fell to a minimum at SAE-20, rising again with further increases in viscosity.

Multigrade Oils. In a study of the influence of oil characteristics on engine octane requirement, Wood and Colyer (125) show that ORI increases as base oil volatility decreases. Different detergents, oxidation inhibitors, and V.I. improvers have varying effects on the base oil ORI. A proper balance of components can drastically reduce ORI whether manifested as spark knock or surface ignition. Overcash, Hart, and McClure (126) correlate oil consumption with viscosity at 350 F. Dach (127) points out that fleet testing of multigrade crankcase oils showed economies in oil and gasoline mileage over Mil-0-2104 lubricants. He also found improved oil mileage but decreased gasoline mileage using two Series 2 oils.

Withrow (128) presents data obtained in the General Motors Research Laboratories on performance of multigraded oils. He finds these oils reduce octane requirement by permitting less build-up of combustion-chamber deposits. These tests do not substantiate claims for ease of low-temperature starting made for these oils.

Low-temperature cranking tests on a number of SAE 10W and 10W-30 commercial crankcase oils are reported by Malone and Selby (129). Their results show that some 10W-30 oils behave more like 20W oils with respect to cranking speed at low temperature. Fischl, Horowitz, and Tutwiler (130) show with low-temperature cranking tests that 0 F extrapolated viscosities are inadequate for classification of SAE winter-grade lubricants. They suggest that viscosities should be determined at a shear stress of roughly 10^6 dynes per sq cm to simulate engine conditions.

Oil and Engine Tests. Relation of physical-chemical properties of oil to engine performance is shown by Bondi, Beaubien, and Diamond (131). By suitable laboratory tests, it is possible to predict the behavior of an oil in an engine with regard to low-temperature sludge, high-temperature varnish, and bearing corrosion. Results of laboratory and turbojet engine tests on seven synthetic lubricants are compared by Davidson and Way (132). Laboratory procedures correlate well for foaming, consumption, wear, sludge formation, and thermal stability characteristics; poor correlation is observed for corrosion tests. Elastomer attack and load-carrying ability were not critical elements in the test procedures used.

Freund and Pallay (133) present laboratory aging tests on motor oils; these are compared with service tests in diesel engines. Conradson carbon and viscosity showed significant increases in both types of test. Wilson (134) reports emission spectrographic analyses of oils from the crankcases of typical engines in gas compressor service. Interpretation requires experience plus a continuing surveillance of machines.

Sawyer, et al. (135), report a large number of engine tests on 15 different oils. Lauson engine and multicylinder radial engine test data are compared; both types of engine were run on natural gas. The authors conclude that oils of low-viscosity index permit excessive ring and cylinder wear in the full-scale engines.

Analysis. An ASTM symposium on diesel lubricating oils brings together information on spectrochemical

analysis published in widely separated places during past years. A compilation (136) of suggested methods of sampling, ashing, and arcing discusses many of the proposed techniques. Barth (137) reports that photomultiplier tubes give better precision and faster results than film methods applied to used railroad-diesel lubricating oils. Techniques are described which eliminate need for ashing and adding internal standards. Perkins, Miller, and Moser (138) find direct determination by emission spectrography of metals in used oils satisfactory for iron, not so for copper; lead can be determined accurately sometimes. The recommendations of ASTM D-2, Section J, for sampling used diesel engine oils, are reported by Simpson (139). Paper chromatography in the examination of used diesel oils is described by Thomas (140). The test is used to screen samples; only if oxidation is shown in the test is the sample allowed to go forward for complete study.

properties of lubricants

Greases. Inorganic thickeners for grease are discussed by Peterson, Accinelli, and Bondi (141). The authors relate the mechanical properties and water resistance of greases made from such thickeners to the organic coatings laid down on the surfaces of the individual thickener particles. McClellan and Cortes (142) describe preparation of electron micrographs of greases by the aerogel technique.

Flow-rate-versus-pressure data are needed in specifying and applying greases and in studying their structures. Brunstrum and Leet (143) review five methods of treating flow data from capillary viscometers to yield significant information about the grease in a particular situation. Weltman and Kuhns (144) describe a highly instrumented concentric-cylinder rotational viscometer used for materials covering a wide range of viscosities. Berner (145) discusses the grease lubrication of rolling-element bearings and presents charts which allow estimation of lubricating intervals as a function of bearing diameter and speed.

Viscosity. Dow (146) has re-examined some of the ASME pressure-viscosity data to determine applicability of the Vogel equation. For the range 0 to 100 C and atmospheric pressure to 50,000 psi, the Walther and Vogel equations are both useful.

Giesekus (147) contributes a mathematical study of the flow of viscous fluids, particularly compressible fluids.

A study of falling-sphere viscometers has been made by Weber (148). The effect of design and operating parameters on the ball constant is discussed in detail.

Flow Experiments. Ozdas and Ford (149) study the factors that influence the delivery of oil to bearings by rings. More-viscous oils are pumped in greater quantity, and a critical depth of ring immersion exists below which oil rate falls off drastically. The authors report experiments to determine the cooling effect of excess oil.

Pumping characteristics of five oils at low temperatures were studied by Starkman and Bridges (150). Pumpability appears to be limited by viscosity pour point but not by gel-type structure in the lubricant.

Viscosity Index. Multigrade lubricants have focused attention on weaknesses of the present viscosity-index system when extrapolated far above the range for which it was designed. A number of systems have been suggested to replace V.I., and ASTM is making a formal effort to screen them and determine their suitability.

Geniesse (151) compares a number of proposed viscosity-index schemes, showing how they relate to the present ASTM viscosity index. Cornelissen and Waterman (152) propose the use of their Fundamental Viscosity Temperature Index to describe viscosity-temperature behavior of liquids. This is the logarithm of the ratio of viscosities at 20 C and 70 C, plus two other numbers needed to completely classify a liquid.

Klaus and Fenske (153) describe the use of their ASTM slope method for characterizing the temperature dependence of viscosity of lubricants. It depends on measurement of the slope of a (straight) line on an ASTM viscosity-temperature chart. Wright (154) proposes a system similar to Hardiman and Nissan's rational viscosity index. The viscosity-temperature relation in this system is characterized by a single constant. Another method is proposed by Larson and Schwaderer (155). Called Viscosity-Temperature Index, this scheme utilizes a straightened Dean and Davis H (100 V.I.) series and a "permanent viscous" series that shows no change in viscosity with temperature.

In addition to the methods described in these references, a number of others which have been previously published are under consideration.

Synthetics. A number of partially fluorinated esters and ethers have been studied by Faurote, et al. (156). Data are reported on viscosity index, pour point, flammability, hydrolytic stability, oxidation stability, response to antioxidants, and thermal stability. Some of these compounds show excellent stability under the influence of heat, moisture, and oxygen. Leguthe and Geiseler (157) describe the manufacture of German synthetic lubricants, the properties of a number of these products, and the service performance of the oils. Applications cited include internal-combustion-engine crankcases, steam turbines, and air compressors.

Miscellaneous. Carroll and Bolt (158) report on low-speed and high-speed lubrication tests of three lubricants, in the presence and absence of pile radiation. The low-speed elements were ball bearings, journal bearings, and gears; ball bearings were used as test elements at high speed. All tests were run at 285 F.; the slow neutron component of the pile radiation was about 5×10^{17} neutrons/sq cm. The radiation markedly shortened the useful life of all lubricants.

books

A book which presents lubrication theory and practice in terms understandable to an engineer has been written by Fuller (159). Starting with a study of viscosity and fluid flow, the author proceeds to a development of hydrodynamic theory and the lubrication of journal bearings. Friction, power losses, bearing ma-

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terials, and the lubrication of industrial bearings are covered. Discussions of hydrostatic bearings and air-lubricated bearings are also included.

Barwell (160) has compiled much of the information that has appeared on hydrodynamic bearings in the last 50 years in a volume on bearing design and lubrication. He also considers variable loading, oscillating bearings, thrust bearings, sliders, externally pressurized bearings, bearing materials, and lubricants.

A small volume by Bowden and Tabor (161) treats the mechanisms of sliding and rolling friction, the effect of oxide films on sliding surfaces, and the behavior of lubricated surfaces.

A CRC report (162) on valve train wear summarizes tests on 295 cars with different combinations of camshaft-tappet design and metallurgy. Four test oils were tried. Design, metallurgy, and oil composition are all shown to be important elements, and all must be taken into account.

Wilcock and Booser (163) have written a volume on design and application of sliding and rolling element bearings. The treatment is practical, a book that should be useful to lubrication engineers and machine designers. Lubricants, lubrication systems, and trouble shooting are discussed in detail.

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Steel for Canadian PIPELINES

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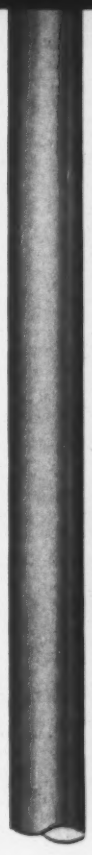

With pipelines planned for the colder regions of Canada, it has become important to determine how pipe performance at −50 F differs from that at ordinary atmospheric temperatures. This paper reports on burst tests at subzero temperatures, made on commercial pipe of various diameters and wall thicknesses. Data on the pipe performance at hydrostatic burst include strength, circumferential stretch, type of fracture, and tendency to shatter.

ENGINEERS of the A. O. Smith Corporation, anticipating pipelines for Canada, have conducted a series of burst tests on their X52 line pipe, a commercial semikilled steel, down to −50 F. Results were compared with more than 2000 normal-temperature tests of all sizes and grades made by the corporation over the years. A single test was performed at +180 F, where 100 per cent ductile shear fracture was assured from transition temperature data, to provide a special comparison.

Test Procedure

The procedure followed in cooling the test pipe to the desired temperature was to fill the entire system with calcium chloride brine, cool the brine by the addition of dry ice, and circulate it by means of a pump through two accumulator pipes connected in series and then to the test pipe and back to the brine cooling tank. A linear perspective drawing is shown in Fig. 1. After the test pipe had attained the uniform desired temperature, as determined by thermocouples cemented to its outside diameter, circulation of the cold brine was stopped. The burst test was accomplished at the desired temperature by pumping brine at atmospheric temperature from the measuring column (water column) with the high-pressure pump into the closed system. This forced only refrigerated brine from the accumulator pipe into the test pipe.

Approximately six hours were required to cool the test pipe uniformly to −50 F. The temperature rise of test pipe during a burst test, which was of approximately 30-min duration, was determined as 5 F per hr after circulation of the refrigerated brine was stopped. This low rate was attained because of the frost insulation and the confinement of the pipe in a test pit.

The burst test at +180 F was accomplished by using the same system with water. The water was heated in the mixing tank by direct admission of steam, and the resulting hot water was circulated through the accumulator pipes and the test pipe.

Chemical analyses were taken from each pipe. The carbon equivalent, C + Mn/4, had no apparent effect on the performance of the individual pipe in the burst tests or the notch-bar tests. The carbon equivalent appears to have little, if any, effect on the other mechanical properties. Results of chemical analysis were:

Pipe	C	Mn	P	S	Si	C+Mn/4
A	0.29	1.03	0.021	0.020	0.02	0.55
B	0.32	1.06	0.017	0.030	0.06	0.585
E	0.27	0.90	0.012	0.023	0.04	0.495
F	0.28	0.88	0.018	0.034	0.04	0.50

Transverse Charpy V-notch tests were made on specimens of each pipe. The results of these tests conducted over a range of temperature from −100 F to +212 F are presented in Table 1. Typical energy-transition temperature curves for X52 pipe are shown in Fig. 2.

Hydrostatic Burst Testing

Test No. A–1 was made on a 15-ft length of Smith X52 line pipe of 26-in. diam × 0.500-in. wall thickness, with welded-on flatheads. The pipe was removed from storage at the Milwaukee Works, and the flatheads were obtained from stock. The pipe was cooled to −3 F, and the burst test was completed with a final temperature of 0 F. It had been estimated that the majority of Canadian line could be at a temperature of 0 F. The yield strength

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Table 1 Transverse Charpy V-Notch Tests: Impact Values in Ft-Lb

Pipe	Pipe size	Test bar size	212 F	100 F	32 F	0 F	−50 F	−75 F	−100 F
A	26 in. × 0.500 in., parent metal	Std.	...	21.7	5.8	3.9	15.6[a]	2.3	2.6
			...	23.2	8.2	5.8	6.4	3.5	2.1
			...	23.2	13.2	5.4	4.3	4.8	4.7
A	Weld zone	Std.	30.5	30.0	16.8	13.9	9.5	3.7	6.2
			31.8	26.1	15.6	11.4	10.9	6.7	7.8
			...	35.0	14.2	12.4	...	5.9	7.9
C	30 in. × 0.344 in., parent metal	2/3 Std.	...	22.1	11.1	6.5	3.9	3.1	3.4
			...	22.1	8.2	5.7	3.1	2.3	2.9
			...	24.0	9.9	5.5	2.5	2.1	2.6
C	Weld zone	2/3 Std.	...	25.9	26.0	14.9	9.9	3.9	8.6
			...	26.1	24.6	14.2	9.0	8.8	7.8
			...	26.3	24.3	19.8	11.1	9.6	7.5
E	30 in. × 0.500 in., parent metal	2/3 Std.	36.6	36.3	14.9	5.8	3.8	...	3.0
			44.6	34.1	8.8	5.2	3.4	...	2.2
			35.7	31.5	14.1	7.7	2.9	...	4.9
E	Weld zone	2/3 Std.	41.3	38.8	20.7	13.7	11.4	...	10.7
			38.2	39.6	24.6	14.9	13.0	...	6.8
			39.6	40.5	22.5	15.6	14.4	...	9.9
F	30 in. × 0.375 in., parent metal	2/3 Std.	25.7	20.3	9.8	8.7	4.3	...	2.2
			26.1	23.2	8.7	7.5	4.3	...	2.1
			25.7	25.3	10.6	9.2	2.1	...	2.0
F	Weld zone	2/3 Std.	25.7	24.4	25.9	20.7	8.7	...	7.7
			26.1	26.1	23.1	18.6	10.6	...	7.8
			26.1	26.1	25.3	19.9	10.3	...	7.8

[a] Specimen interfered with pendulum—high value.
Standard size test bar is 0.394 in. × 0.394 in. 2/3 standard test bar is 0.262 in. × 0.394 in.
The weld zone in a flash weld is defined as the material which has been heated above the transformation temperature. The parent metal represents steel away from the heat-affected zone of the flash weld.

of the pipe was obtained from the pressure at a volumetric set of 0.2 per cent as measured by the water column, and the ultimate strength thus determined compared favorably with the transverse strip tensile tests. The circumferential stretch, as measured after burst, was an average of 3.91 in. (In a survey of 1200 burst tests made at normal atmospheric temperatures, the average stretch in 1/4-in. to 1/2-in. wall pipe was 2 5/8 in. after burst.) The length of burst was approximately 6 ft, with origin of fracture 3/4 in. from the longitudinal weld seam. The pattern of fracture is shown in the photograph, Fig. 3.

Test No. A-2 was made on the other half of pipe A, again with flatheads. The pipe was cooled to −50 F and the burst test was completed with a final temperature of − 48 F. A comparable yield strength to test No. A-1 was reached. However, the girth weld of the heavy flat head fractured before the ultimate strength of the pipe steel was realized. The bending stress at the root of the integral chill design due to stretching of the pipe caused premature failure through the girth weld. An average circumferential stretch of 0.63 in. was measured after the head was torn off. Eighteen inches were removed from the failed end of this pipe and semielliptical ASTM A212 Grade-B heads were welded on and the pipe was retested.

Low-Temperature Stretch

Test No. A-2-1, a retest of test No. A-2, was conducted with the pipe cooled to −49 F with a final temperature of −46 F at burst. The yield strength as measured by water column at 0.2 per cent volumetric set was increased approximately 6000 psi by the cold expansion of the previous test. The ultimate bursting stress as calculated was approximately 2000 psi higher than test No. A-1 on the other half of this pipe. An additional average 3 1/2 in. of circumferential stretch was produced in this test, which again is normal ductility for similar pipe tested at atmospheric temperature. The additional cold expansion of the previous test had not impaired the ductility of this pipe as measured by the low-temperature burst test. Failure started 1/2 in. from the longitudinal seam near one end of the pipe, and crossed this weld several times before encircling the pipe 5 ft from the end and progressing into the head. The fracture surface was cleavage in nature with chevron markings.

Test of Field Girth Weld

Test No. C-1 was made on pipe received from customer storage in the southern Illinois area. The pipe was cooled to −52 F (it had been estimated that approximately 10 per cent of a Canadian line could be at temperatures estimated at −50 F for approximately six months of the year) with a final temperature at conclusion of the test of −48 F. The pipe exhibited a high yield strength as measured by the water column at 0.2 per cent volumetric set. Even though the calculated burst strength was 97,000 psi, the pipe stretched circumferentially an average of 4.82 in. which is greater than average stretch experienced during normal burst testing at atmospheric temperature. (In over 2000 burst tests surveyed the maximum stretch ever measured was 6 in. on a burst pipe at normal atmospheric temperature.) Fracture originated 1/2 in. from the longitudinal weld

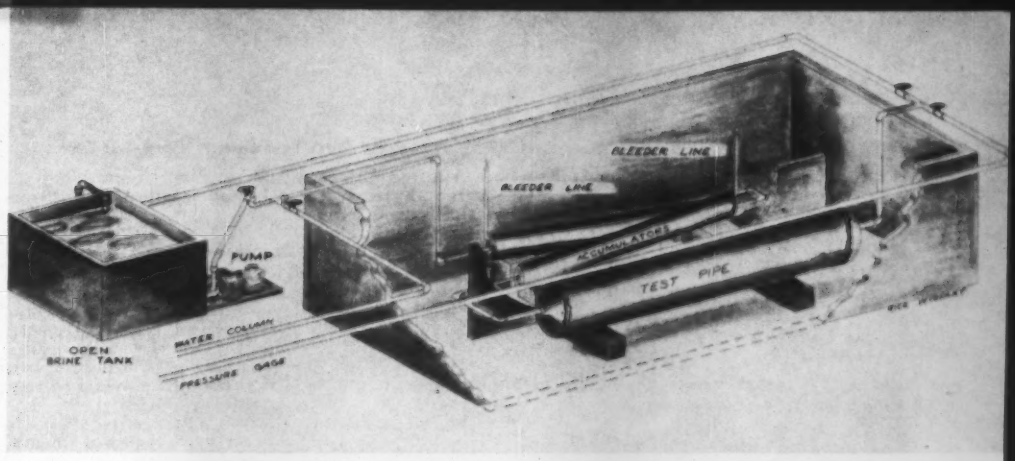


Fig. 1 The test setup. Calcium chloride brine, cooled by dry ice, circulates until the system reaches test temperature. Then a high-pressure pump applies pressure through the water column. Brine-tank capacity is 750 gal, accumulators 60 gal each, and each test pipe holds 550 gal.

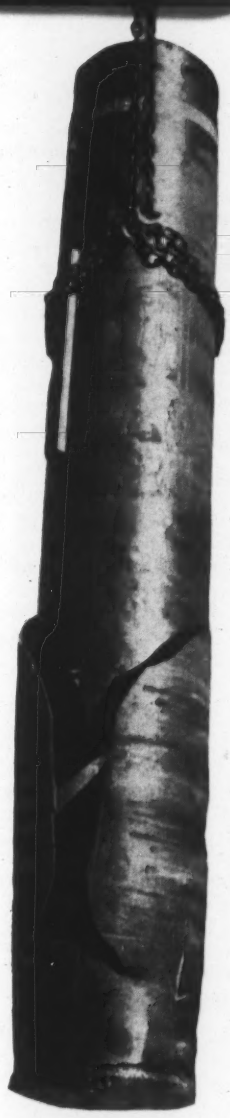


Fig. 3 The pattern of fracture in the first test, No. A-1. The fracture surface was cleavage in nature, with chevrons pointing to the origin.

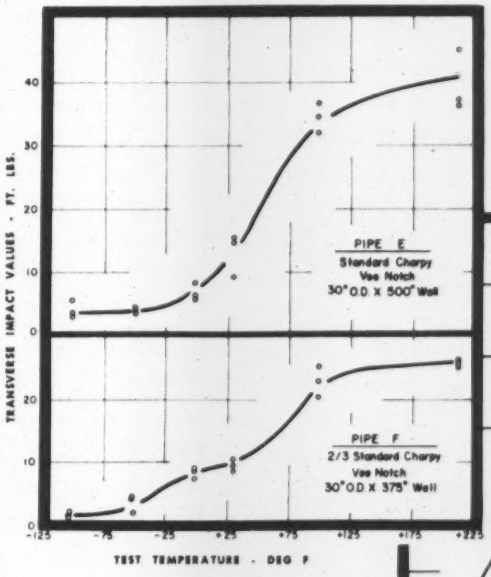


Fig. 2 Energy-transition temperature curves of Smith X52 pipe steel

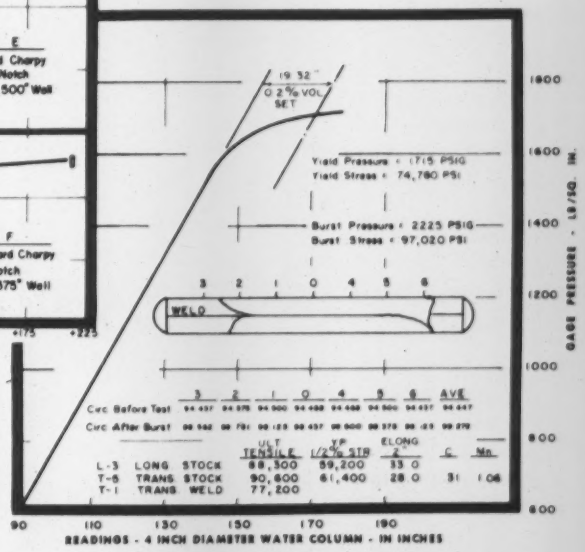

0.2% VOL SET
Yield Pressure = 1715 PSIG
Yield Stress = 74,760 PSI
Burst Pressure = 2225 PSIG
Burst Stress = 97,020 PSI
WELD
GAGE PRESSURE - LB/SQ. IN.
READINGS - 4 INCH DIAMETER WATER COLUMN - IN INCHES

Fig. 4 Test No. C-1, at minus 50 F. A 15-ft length of pipe, of 30-in. diam and 0.344-in. wall, with semielliptic heads welded on. The pipe exhibited a high yield strength as measured by the water column at 0.2 per cent volumetric set.

Fig. 5 For test No. C-1-2, a circumferential weld was made, using field-welding procedures and staggering the longitudinal weld 18 in. Fracture started in a longitudinal seam and ran into one head; in the other direction, the fracture proceeded through the girth seam, encircling the pipe.

Table 2 Burst Test Data

Pipe No.	Size	Ult. strength calc. from burst pressure	Calc. stress at 0.2 per cent vol. set	Strip tensile test cut from pipe — Description	V.T.S.	Y. S. ½ per cent stretch	Elong. per cent in 2 in.
A–1	26 in. × 0.500 in. 15 ft long	82,500	63,960	Long. stock	80,000	63,600	37.5
				Trans. stock	82,700	68,300	34.0
A–2	26 in. × 0.500 in 15 ft long	70,850	64,870	Heavy welded head blew off before pipe reached ultimate burst pressure. This stretched pipe ⅝ in. in girth, and semielliptical heads were welded on and pipe was retested as A–2–1.			
A–2–1	26 in. × 0.500 in. 13 ft 3 in. long	84,760	70,590	This was a retest of pipe A–2. Note additional stretch of girth of 3 in. in addition to ⅝ in. during first test.			
C–1	30 in. × 0.344 in. 15 ft long	97,020	74,780	Long. stock	88,300	59,200	33.0
				Trans. stock	90,600	61,400	28.0
C–1–2	30 in. × 0.344 in. 19 ft long	85,020	73,685	This was a test of pipe with a field girth weld.			
E–1	30 in. × 0.500 in. 15 ft long	76,200	70,650	Long. stock	80,900	61,700	35.5
				Trans. stock	81,800	64,500	32.0
F–1	30 in. × 0.375 in. 15 ft long	81,000	61,400	Long. stock	85,500	60,100	32.5
				Trans. stock	85,700	64,400	31.5

Note: Minimum physical properties of A. O. Smith X52 line pipe used in tests: 77,000 psi T. S., 52,000 psi Y. S. (transverse), 46,000 psi Y. S. (Longitudinal).

seam as shown in Fig. 4. The fracture surface was of a cleavage nature with chevron markings.

Test No. C–1–2 was made on a length of the same pipe as tested in No. C–1, with a circumferential weld introduced, using field-welding procedures. Radiographs revealed some evidence of lack of penetration which was judged acceptable by Standard API 1104. Semielliptical heads were welded to this pipe. The pipe was cooled to −49 F and at completion of test the temperature was −46 F. Fig. 5 shows results of this test. The yield strength was equal to that determined in test No. C–1. The ultimate bursting strength was lower than that of the other end of this pipe (test No. C–1) but was 18 per cent greater than the minimum ultimate strength specified (72,000). A circumferential stretch of 1.1 in. was recorded on both sides of the girth seam and ⅞ in. on the field weld. The fracture surface was of the cleavage type with chevron markings.

The Impact Test

Test No. E-1 was made on a 15-ft length of Smith X52 line pipe of 30-in. diam × 0.500-in. wall, with welded-on semielliptical heads. This pipe was shipped from customer storage in southern Texas. The pipe was cooled to −50 F and a semielliptical tup weighing 750 lb was dropped from a height of 13 ft, 4 in. to impart 10,000 ft lb energy to the pipe which was at a pressure simulating the working pressure. A saddle made from a cutout from a 30-in. × 0.344-in. pipe was placed at the point of impact to prevent gouging of the test pipe. The drop of the tup was made over the longitudinal weld seam of the test pipe. Extra-heavy pipe nipples with high-pressure valves were provided at both inlet and outlet of the test pipe so that working pressure could be maintained. The drop of the tup severely gouged the saddle with no apparent damage to the test pipe. Both extra-heavy nipples broke from the heads as a result of the impact with subsequent escape of the cold brine.

After the piping system was repaired the pipe was cooled to −50 F and a burst test was made. The temperature was −47 F at completion of the test. The yield strength as determined by the water column at 0.2 per cent volumetric set was several thousand psi higher than determined from transverse strip tensile tests which could be due to expansion caused by surge of pressure during the drop test. Even though the pipe was subjected to a severe shock at subzero temperature, the burst strength was 6 per cent above the minimum ultimate strength specified (72,000 psi). Fracture started in the longitudinal weld zone and progressed through the head until a section of the pipe was blown out. Fracture surface was cleavage with chevron markings throughout, including the ¾-in-thick ASTM A212 killed steel heads.

Test for 100 Per Cent Shear Fracture

Test No. F–1 was made on a 15-ft length of Smith X52 line pipe 30-in. diam × 0.375-in. wall with welded-on semielliptical heads. It was desired to produce a shear-type fracture, and a test temperature of +180 F was selected. The water in the tank was heated and circulated through the pipe until a temperature of +182 F was reached. At this point, the burst test was started and final temperature at the completion of the test was +179 F. The pipe exhibited calculated yield and ultimate burst strengths nearly equal to those determined from transverse strip tensile tests. Circumferential stretch after burst averaged 3.0 in. Fracture started 4 in. from the longitudinal weld seam and was characteristic of a 45-deg shear type without chevrons.

Summary

The results of strip tensile tests and a summary of the burst tests are presented in Table 2.

Data secured from burst tests of Smith X52 grade line pipe at subzero temperatures were within the normal range of tests conducted at ordinary atmospheric tem-

peratures. The pipe exhibited the same ductility, and the fracture appearance after burst testing was cleavage with chevron markings, the same as when tested at ordinary temperatures. The carbon equivalent had no apparent effect on the performance of the individual pipe in the burst tests or the notch bar tests. It is difficult to correlate the performance of the pipe with the Charpy V-notch specimens of the material based on some arbitrary value of energy between the upper and lower plateaus of the energy-temperature transition curve, as measured by the Charpy V-notch bar. Whether the pipe is to be in service at +40 F, where there is the longest service record, or at 0 F, the steel is on the lower plateau of the energy-temperature transition curve.

To obtain shear-type fracture in the burst test, the results of a single test at +180 F would indicate that the pipe should be at a temperature which is well out on the upper plateau of the energy-temperature transition curve. The average circumferential stretch of the pipe burst at +180 F was no greater than that obtained in atmospheric or subzero temperature tests. Shear-type fractures in semikilled steels have not been obtained to date on line-pipe burst tests at atmospheric temperatures.

There is no mystery in obtaining 100 per cent shear-type fracture in a steel structure with the knowledge we now have of the transition temperature on steel. If the pipeline engineer wants to operate steel at 0 F, and desires to have a notch-ductile steel at that temperature which will always fail in shear, he is going to have to pay the price for specially alloyed, heat-treated steel with a Charpy transition temperature of at least −100 F, and a value between 20 to 25 ft lb Charpy V-notch energy, depending on whether the steel is hot-rolled or heat-treated.

The field girth seam showed ductility as measured by the stretch during burst testing at −50 F. There was no attempt made to place artificial notches in the pipe tested; however, in some instances there were defects up to 12½ per cent of the wall thickness such as chain marks, score marks, and gouges due to handling, which did not affect the test results. None of the pipes burst at 0 F or −50 F had any tendency to shatter. All burst fractures were of the cleavage type with chevron markings. All pipe tested at −50 F developed in excess of the minimum mechanical properties of yield and tensile strength required for X52 expanded line pipe.

Conclusion

These results provide a basis for judgment on the use of ordinary steels for low-temperature service condition, as against specially alloyed, heat-treated steel (if obtainable in quantity) which would guarantee more notch toughness as insurance against the bad defect in the field that can cause a blowout burst. The facts suggest that it is more economical to use commercial semikilled steel of Grade X52 and exercise greater care in the field operations of welding and trenching.

This implies increased supervision and inspection prior to covering the pipe, to prevent sharp, cracklike defects. Standards of inspection must take into account the metallurgical hazard due to notch effect.

Gyroscopes for Inertial Navigators

(Continued from page 835)

employing preloaded bearings of the correct contact angle for isoelasticity. The rotor and housing shapes are also designed to achieve this condition. Note that the web of the rotor is considerably narrowed adjacent to the shaft, so that the shaft and bearings will be protected from excessive loading due to axial contraction of the rotor at operating speed.

So far, discussion has been confined to ways of minimizing the disturbing torque L in the expression $L = \omega H$. Maximizing angular momentum H is a theoretically sound approach to the problem. However, there are practical limits to what can be done in the direction of increasing mass and radius of gyration of the rotor. Weight and size are always at a premium in aircraft. Every pound added to an individual gyroscope usually adds much more than three pounds to a three-axis platform.

Navigation-Gyroscope Rotors

Navigation-gyroscope rotors are commonly run at velocities which are very conservative as regards ratio of operating stress to ultimate bursting strength. It is always tempting to raise the rotor spin velocity. Theoretically, this looks like the cheapest way of improving the ratio of angular momentum H to disturbing torque L. Unfortunately, several sources of disturbing torque go up as the first or higher-power function of spin velocity. There might be mentioned distortion of the rotor—and liability to mass shift—under centrifugal acceleration, which varies as the square of the spin velocity. In general, also, spin-bearing friction and rotor-windage torque at high speeds require a motor power and heat input which largely offsets the advantages of higher H. The only known types of rotor support which are virtually frictionless, viz., magnetic and electrostatic supports, have serious practical limitations as regards operation on an accelerated base.

Rotor-drive motor considerations in navigation gyroscopes are essentially similar to those in other kinds of gyroscopes, except that strictly constant-speed operation, on the average, is usually essential. The reason for this is partly to avoid mass shift due to variable centrifugal or thermal distortion of the rotor, and partly to insure that any deliberately applied control torques will result in a predetermined space-precession rate. This latter consideration is absent in gyrocompasses, gyroverticals, and other gyroscopic equipment wherein the torquers function in a null system.

Accordingly, one usually finds synchronous motors of the hysteresis type in navigation gyroscopes. Every effort is made to minimize power and heat inputs, by efficient design and by using as small a motor as will bring the rotor into synchronism with a reasonable margin of safety.

Improvement of the navigator gyroscope did not come about all at once as the result of any single stroke of genius. In its essentials it is similar to the very first gyroscope made by the technician Froment for Léon Foucault over 100 years ago. Progressive increase of accuracy is the result of ingenious solutions of a number of problems and extremely close attention to a large number of details in engineering, design, and fabrication.

The engineer's plan for California's future waits, embroiled in politics. In this Wright Lecture, engineers are urged to enter the political arena.

THE life of the engineer is one of service to humanity, but the service is impersonal. He does not come into direct contact with the people he serves. The woman who appreciates her refrigerator may thank the dealer who sold it to her but she is seldom conscious of the engineer who designed it. The doctor who gave her medicine and the lawyer who gave her legal advice performed personal services of which she is very well aware, and she is grateful. The engineer may have rendered her a greater service, but the gap between donor and recipient is so great that the recipient is not even conscious of the existence of the donor.

The engineer is a wholesaler of service. Other professions are retailers of service and they are much closer to their customers.

Another reason why the public may be unappreciative of the service rendered by engineers, and why it is slow to call on him, is that the typical engineer is reluctant to talk about his accomplishments lest he appear vain and a braggart. He expects the results of his work to be sufficiently tangible to speak for him. He does not present his ideas in a clear, convincing manner. Typically, he resents the fact that the public does not understand or accept his ideas until a public-relations expert has stepped in. The public seems to have the idea that the engineer is inarticulate and cannot state an idea simply and logically, but must have an attorney to speak for him. For instance, the head of the Santa Clara Valley Flood Control districts is an attorney instead of an engineer.

Dr. Wright suggested that if engineers would interest themselves in politics it would help to correct this condition and place them in positions where they could use their analytical ability to shape the policies of our country. U. S. Senator Ralph Flanders of Vermont is an example of an eminent engineer whose profound analyses of the problems of the government are received with a respect that is not accorded to the statements of the typical politician. Roy V. Wright was unquestionably correct when he said that politics offers a field for service that engineers should not neglect. Engineers should become more active in politics.

Engineering has been defined as: "That profession whose purpose is to make the resources of nature available to mankind." It is fitting therefore that we consider one of the greatest projects of all time to serve man by making millions of acre-feet of water available to him.

Based on the 1957 Roy V. Wright Lecture presented at the Semi-Annual Meeting, San Francisco, Calif., June 11, 1957, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The Californian Paradise

Engineers may be remiss in politics but they have nevertheless been responsible for many of the blessings which their fellow men enjoy. Perhaps nowhere in the world is that truer than in California where nature and the engineer have combined to create a paradise. The network of electric distribution which brings power to a million switches—waiting for the command to bring in the voice of Lily Pons or to turn the powerful rolls in a steel mill—is essential to our well being. It would be impossible to describe all these works for which the engineer should be credited, but we can get an idea of the whole by considering the California water problem —and the California Water Plan which has been devised by engineers to solve that problem.

California is a state having an area of almost exactly 100 million acres. It is about 225 miles from east to west and 750 miles from north to south. It has nearly every natural resource found on earth. Within a span of 90 miles it has a moutain that towers 14,495 feet above sea level and a desert which is 282 feet below sea level. It has a sea coast that is about 1000 miles long and it has abundant harbors along this coast and on inland rivers and bays. About three fourths of the state is covered with rugged mountains and about one tenth of the state is irrigated valleys. Cities and urban developments occupy about one per cent of the area of the state, and about 15 per cent of the area is covered with rolling foothills between the valleys and the mountains. It has timber in abundance and it is rich in minerals. Its climate varies from the heat of the desert to the cool sea shores and to winter snows in the mountains.

Redistribution of Water

These resources, varied and plentiful as they are, would be largely useless without a supply of water. For instance, California, with less than 8 per cent of its population living on farms, leads all the states in cash income from agriculture. Most of this agricultural land is irrigated and about 90 per cent of the water used in California is used for irrigation. This intensive development results in California farmers receiving about 12 per cent of the agricultural income of the United States while the area of their land is only about 2 per cent of the total area. Every day some 1000 people come across the border to settle in California. New industries are started and branch plants are continuously built in California. Seashore and mountain recreation and health resorts are being continually established. All of these require increasing quantities of water. The number of people to be served continues to increase but the rainfall remains nearly constant.

California has an abundant supply of water, but unfortunately about 70 per cent of this supply of water is in the northern third of the state, which needs only about 22 per cent of the total supply; the southern two thirds of the state, which needs 78 per cent of the total, has only about 30 per cent of the supply. The average annual rainfall in some places in the northwest part of the state is over 100 inches and it is less than 2 inches in some places in the southeast part. Since it is not possible to move fertile valleys of the south into the rugged mountains of the north, it is necessary to move the water from the north to the south. The problem is further

complicated by the fact that in California it rains when little water is needed and the sun shines all summer when water must be used.

The Water Plan

California is saying to engineers: "It is your duty to store, on the average, 21 million acre-feet of water each winter, and each summer to move it, on the average, about 375 miles and deliver it to our people." This is an order for storage of about 29,000 million tons of water each year and a movement of about 10,000,000 million ton-miles of water each year. This is what the California Water Plan is designed to do.

The Plan requires the construction of some 260 new dams creating reservoirs that will store 40 million acre-feet of water. The present capacity of surface water storage is about 20 million acre-feet. This Plan is estimated to cost about 12 billion dollars and its design is based on the ultimate development of the state. Its operation will serve the millions of people already in California and those who are coming into the State.

The population of California is increasing at the average rate of 2000 every 24 hours. The service planned by the California Water Plan consists not only in the conservation and distribution of water but also the generation of hydroelectric power, flood control, and the development of fish, wild-life, and recreation facilities.

Feather River Project

The first unit of the California Water Plan, the Feather River Project, was authorized by the 1951 State Legislature. This project includes the Oroville Dam on the Feather River, 60 miles north of Sacramento. This will create a reservoir of $3^1/_2$ million acre-feet capacity and provide for the generation of 440,000 kw of electric power. It also includes the necessary pumping plants, canals, tunnels, and pipelines to convey this water, some of it more than five hundred miles, down through the central valley and on to San Diego in the south. On the way it will serve the people of the whole central part of the state. This project is estimated to cost about $1.5 billion.

Salinity Control

In working out the California Water Plan, innumerable secondary problems presented themselves and have been solved, or will have to be solved, before the Plan is in operation. Typical of these problems is that of salinity control. Fresh water comes down from the mountains into the rivers. Salt water comes up the same rivers from the Pacific. Fresh water is essential for irrigation and salt water is essential for navigation.

If the two mix, the value of the fresh water is destroyed. Many types of barriers to keep the two kinds of water separated have been proposed. The Reber Plan presents the most elaborate scheme. This would use two earthfill dams across San Francisco Bay. The proponents of this plan claim that it would result in the formation of fresh-water lakes in lower San Francisco Bay and in San Pablo Bay, Carquinez Straits, and Suisun Bay.

These bays are all bodies of salt water fed from the Pacific through the Golden Gate. The opponents of this plan point out that these bays are the septic tanks for the entire Bay area and that they are flushed out twice a day by the tides. Each tide brings in about 14,000 tons of oxygen and this now keeps these bays reasonably clean. The tides also scour the ship channel through the Golden Gate. The opponents of the Reber Plan therefore claim that it would result in the bays being transformed into cesspools instead of into fresh-water lakes, and that the Golden Gate ship channel would become blocked and require excessive dredging.

Many studies of this problem were made and the State Water Resources engineers decided that the best plan is the so-called Biemond Plan. This Plan rejects the idea of the Bay barriers and proposes to divert pure water from the Sacramento River at points above the encroachment of salt water, and to distribute this fresh water from these points through concrete-lined canals. Army Engineers are now building a model of the entire San Francisco Bay area and this is expected to furnish the answers to the many perplexing questions regarding this area.

A Future Beyond Calculation

When this gigantic project is in operation, engineers will have made the resources of nature available to man on a scale unequaled in history. The vast central part of California will be a paradise of growing crops instead of a semiarid region of ghost towns in which it is difficult to make a living. Men will find employment in factories which cannot be built unless there is water for their operation. Cities and schools will be built and millions of men and women will live and raise families in a climate that is salubrious. All these benefits and many more are possible because engineers have had the vision to design the California Water Plan.

However, men elected to the legislature are today debating and wrangling about the construction of this great project. They are divided into two factions;

The Wright Lecture, established in 1949 in honor of Roy V. Wright, President of the ASME in 1931, is a tribute to his leadership of the engineering profession in political awareness and participation. He urged engineers to serve their country in every way, emphasizing service through public life. In this 1957 lecture, a California engineer and educator, who knew Dr. Wright, gives immediacy to the Wright thesis.

The CALIFORNIA Water Plan

By George L. Sullivan, Dean Emeritus of the College of Engineering, University of Santa Clara, Santa Clara, Calif.

the north and the south. Each refuses to allow progress unless its area gets just what it wants. It is discouraging to observe the process of legislation where the activating motive is usually "what effect will it have on my chance of re-election" rather than "what effect will it have on the welfare of the country?" The Governor of California was recently quoted as saying that needed legislation could be passed if "political ambitions and partisan political positions were settled."

The Political Arena

Dr. Wright invited engineers to enter the political arena. It is one in which no holds are barred. The typical engineer hesitates; he is a neophyte and expects to apply absolute values. He knows that if a structure is properly designed and built it will function as planned, but if the legislature says that the water shall not flow down from the mountains to the thirsty valleys, the plan will never reach fruition. Dr. Wright's appeal is that engineers enter politics and bring to it high standards which will substitute the ideal of the common good for the present standard of individual benefits.

Engineers can establish high standards in policy-forming political positions only by becoming active in politics and actively supporting men of high ideals, or by running for office themselves. Engineers are, in general, men of high ideals but are woefully lacking in unity of action and in political sense. They are generally regarded as men of integrity and honesty of purpose, and they could exert a powerful influence. However, in our democratic form of government any group which will not actively participate in politics will have little or no influence on the kind of government under which we must live. The self-seeker and the crook love to see inactive citizens.

The engineer in his work must be exact in analysis, and this exactness and single purpose for right is badly needed in every position in the government, from that of a city councilman to President of the United States. However, the ward worker who will work with his neighbors for better government is just as important as the office holder. This fact offers an opportunity for young men to become active in politics without making a career of it. In this way engineers could join with others who are concerned with abuses in our government, and the united efforts of such people certainly would result in improvements.

Engineers as a group are not civic minded. They are too much wrapped up and interested in their designs. They forget that the inaptitude of government may cause their finest designs to be perverted to the destruction of mankind instead of, as they intended, to the good of their fellow men. If engineers were more active in politics, our State Governor could not complain that "political ambitions and partisan political positions" were determining the actions of our legislators.

If engineers had more influence in the California Legislature, the California Water Plan would have a much better chance of bringing water, which is wasting down the Sacramento River, to the valleys where it is needed. The water flowing down the canals would be a symbol of the integrity and judgment flowing into our political system. This world would be a better world if engineering students were taught more about people and about politics even at the expense of being taught less about materials.

By F. R. Spurrier

Utica Bend Corporation, Utica, Mich.

DESIGNING THE

The design objectives in gas-turbine engines for medium-displacement naval vessels include most of the requirements for aircraft units, but in different degree. Such vessels, notably escort types, have duty-profile characteristics demanding short periods at maximum power, and long periods at cruising power which may be only 15 per cent of the maximum. Restrictions on weight are less severe than for aircraft units, and it is practical and necessary to design for an operating life ten times as great. That means a blade life of 1000 hr at rated power, as against 100 hr for the aircraft engine, and 10,000 hr at cruising power as against 1000 hr in aircraft.

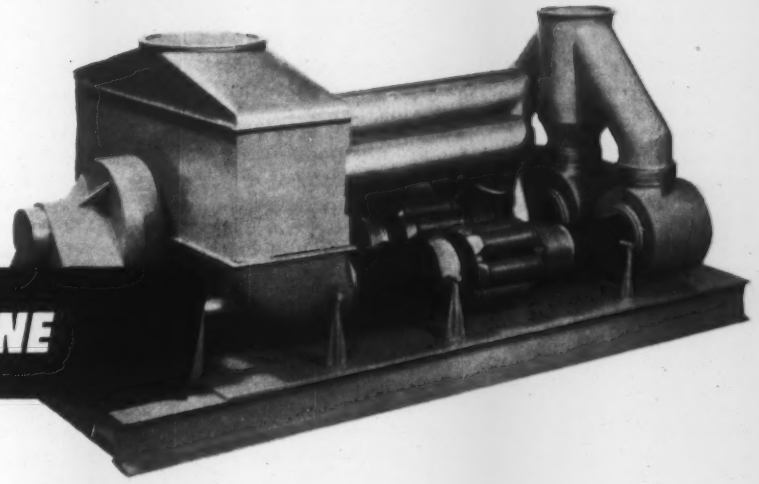
Economy must be assured at cruising conditions. This has led, in the past, to the design of complex engines employing multiple compression stages with intercooling and expansion stages having reheat combustion between the stages. The development of such engines into practical power plants requires that many components be matched satisfactorily over a large range of operating speeds.

Basic Engine Type

The simplest arrangement, employing a single rotor and one turbine unit, cannot maintain acceptable values of specific fuel consumption over a large speed range. Increased cycle efficiency can be obtained by the use of a separate power turbine, which permits the compressor section (with its own driving turbine) to operate at a higher speed and compression ratio for a given power-turbine speed—a "free-power turbine." Through in-

Contributed by the Gas Turbine Power Division and presented at the Gas Turbine Power Conference, Detroit, Mich., March 18–21, 1957, of The American Society of Mechanical Engineers. Condensed from ASME Paper No. 57—GTP-7.

This model of a ship installation illustrates the multiengine concept as applied to naval gas turbines. Total weight of the basic engines is less than that of a single large turbine, while regeneration, essential at low power outputs, is applied only to the single engine used for cruising. Further advantage accrues from the use of "free-power" turbines, in which the independent compressor units can be operated at higher speeds than the turbines.



MARINE GAS TURBINE

A design philosophy for the gas-turbine engine as main propulsion unit for naval escort ships. Free-power gas turbines in multiple, for reliability and to preserve economy over the vessel's wide range of power demand.

dependent operation of the compressor unit, specific fuel consumption is reduced at the lower power-turbine speeds in the highly loaded condition. But the power output at such a condition is several times greater than that required to match the speed/power curve of the ship's propeller. A reduction in torque at the power turbine can be obtained only by operating the gas producer section at lower speed and efficiency. The single engine is, therefore, oversized for the lower power-turbine speeds.

This condition may be overcome by the use of several engines, driving a single output shaft and propeller. Since these units can be operated singly at the lowest powers, and together at the highest powers, the required speed/power curve can be obtained at acceptable values of specific fuel consumption. Thus multiple engines of basically simple design can be employed to produce acceptable economy far more attractively than the complex engine. Reliability is improved by virtue of the simplicity of the individual units, as well as by the fact of several independent engines.

With multiple units, the total weight of the basic engine is reduced for a given output and stress level. This follows from the fact that, when scaling an engine, if all dimensions are increased linearly by the same factor and if the engine is then operated at the same tangential blade speed, the stresses in the parts will remain the same. The power output, which is proportional to the air mass flow, will be increased by the scale factor squared. The weight, however, will be increased by the scale factor cubed. This favors the use of small units where low specific weight is required. But in smaller engine sizes, the weights of the control system, pumps, and accessories, together with manufacturing limitations, tend to influence the total weight to a greater degree, and a point is reached where further reduction in size will produce no improvement in specific weight. This point probably corresponds to an engine size in the range of 20 to 40 lb per sec at the present stage of the art.

The deficiencies of the simple-aircraft type of engine at low power outputs can further be alleviated by the use of a heat exchanger. In marine installations, regeneration is most effectively employed during low-compression ratio cruising, where economy is important, rather than at the high power outputs required for brief emergencies. In the multiengine installation, therefore, only the single engine used for cruising need be regenerated. Since the space available is relatively great, compared with aircraft installations, and frontal area is unlimited, it is possible to use the stationary type of exchanger rather than the more compact and complicated rotary type.

The Main Components

Compressor. Reasonable fuel economy (0.6 lb per shp-hr) in the multiengine, simple-cycle type of power unit demands the use of pressure ratios of the order of 7:1 at the nonregenerative rated power condition, and 5:1 at the regenerative, reduced-speed condition. These pressure ratios can be achieved either by a two-stage, centrifugal compressor, or by a multistage axial compressor. In the past, the centrifugal machine has enjoyed a favorable reputation for mechanical robustness, cheapness, and flexibility of operation. Axial-flow machines have demonstrated superior aerodynamic efficiency, and their small frontal areas have favored

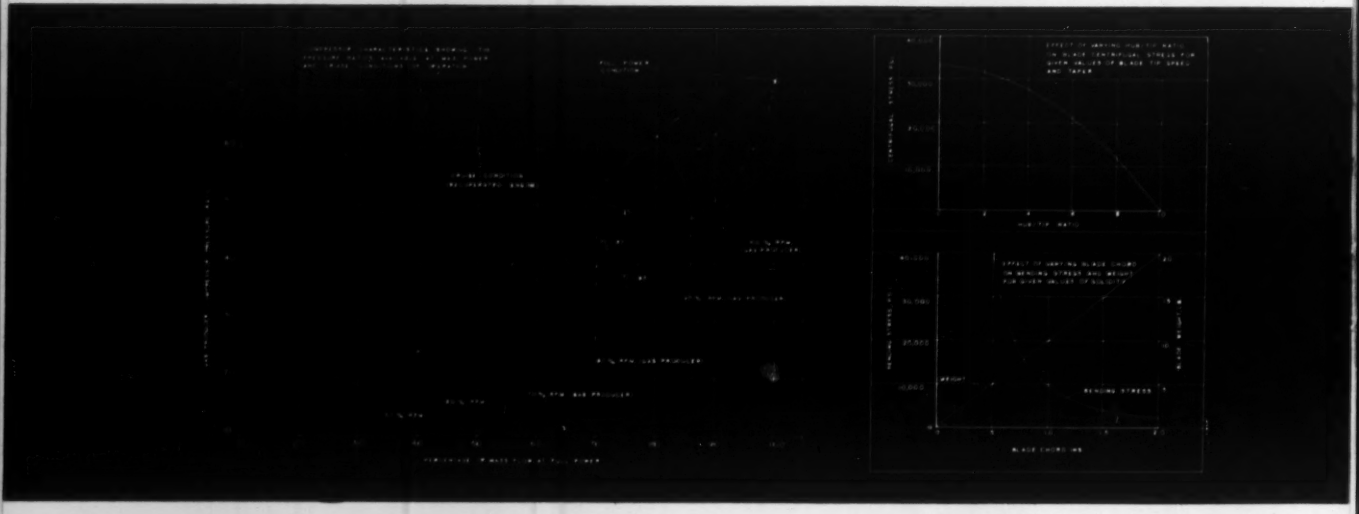
their employment in aircraft engines. The generally reduced flexibility of the axial machine arises from its typically steep pressure-flow-quantity characteristic which requires operation of the unit near surge to obtain high-pressure ratios and efficiencies. The flatter characteristic of the centrifugal machine permits its operation away from the point of surge, but the reduction in ultimate achievable compressor efficiency imposes too great a compromise on engine performance, in view of the present state of the art of axial-machinery design.

The most recent axial-compressor designs have relatively flexible characteristics, with large areas of high efficiency over a wide range of speeds. The employment of the multiengine concept, with engines of the free-turbine type, reduces required compressor-speed range to a minimum and favors the use of the high-efficiency axial machine.

For naval use, the axial machine can be so designed as to reduce operating stresses and provide a rugged machine. A large hub/tip ratio may be employed to minimize the blade centrifugal stresses for a given tip speed and taper ratio, and the blade chords may be made large to minimize the gas-bending stresses. The resultant increases in weight and frontal area are of small significance in a marine engine. The blade chords must be sufficiently large to withstand continuous operation under heavy, critical-frequency excitations. The use of stainless-steel blading is indicated, to provide the maximum resistance to vibration-induced fatigue augmented by the highly corrosive atmospheric conditions

Turbine. The requirement for maximum specific power and minimum specific fuel consumption dictates the employment of the highest possible turbine-inlet temperature. To accommodate the high gas temperatures, turbine-blade stresses are reduced to a minimum by the use of large chords and taper ratios. The use of the best high-temperature, forged blade alloys is appropriate, while economy in the use of critical alloys is possible by the employment of a lower-temperature heat-treatable alloy for the turbine disks. The disk-rim temperature can be maintained at a sufficiently low value by the use of a small amount of cooling air tapped from the compressor outlet. The provision of a small extension of the blade, between the platform and the fir-tree fixing, reduces the heat input to the disk rim from the blades and reduces the thermal stresses in the disk. This is important in an engine designed for long life with many reversals of stress.

In the design of stator assemblies, the use of redundant types of structure must be avoided. The hot vanes may consist of small individual pieces supported and located in position but free to expand and contract independently of the supporting structure. A double-wall structure, which reduces the rate of heat input to the turbine casing, is provided if the rotor shrouds are formed as a series of short segments supported and located from the casing in a similar manner to the stator vanes. This construction permits the casing to operate at a much lower temperature which, in turn, permits the use of a cast steel having a low coefficient of thermal expansion. This reduces the



met at sea. Provision must be made for the removal of salt deposits from the blading during operation, by means of fresh-water sprays in the compressor intake.

Compressor castings can be of stainless steel of heavier and stiffer design than in aircraft engines, reducing to a minimum the amount of tip clearance lost due to casing distortion. A longer, more efficient diffuser can be used. Compressor casings and diffuser can be designed so that ready access to the engine bearings is possible without complete engine disassembly.

amount of blade radial-tip clearance necessary to prevent rubbing during the transient conditions arising after starting and run-down.

These considerations apply, in particular, to the high-pressure turbine driving the compressor. The mechanical design of the power turbine may be similar to that of the compressor turbine, although the provision of extended blade roots and disk cooling is usually unnecessary. The power-turbine temperatures and stress levels are relatively low.

A length of diffuser section between the two turbines favors the power turbine by permitting a reduction in the gas axial velocity and blade speed to suit the lower temperature level. The exhaust diffusion in marine engines must be more complete than that acceptable in turbine-propelled aircraft, where quite large values of exhaust velocity can give good propulsive efficiencies. The use of a heat exchanger in a marine engine requires the diffusion of the exhaust to a low velocity to minimize pressure loss.

Combustor. Since lightness and compactness are not essential, marine combustors may be designed to achieve intensities of less than one quarter of typical aircraft values, to the great benefit of efficiency in terms of pressure loss. The relative unimportance of frontal area would suggest location of the combustor remotely from the engine axis. This would permit some reduction in rotor length, and it might be claimed that a more uniform temperature profile could be obtained at the turbine inlet because of an additional length of duct available for mixing. However, such a remote location necessitates a length of hot, high-pressure duct with elbow bends introducing pressure losses. It impairs control of inlet-temperature distribution. Such control is desirable because it permits the development of a radial temperature profile which reduces the temperature in the highly stressed region at the root of the blade and increases it toward the tip. Considering all the factors, remote location of the combustor is difficult to justify even in the event that more bearings and supports be required with the "in-line" arrangement.

Right: The high-efficiency axial compressor, favored in aircraft turbines, can become a durable marine design, since weight and frontal area are not restricted. These curves show how increased blade chord and increased hub-tip ratio can reduce stresses and contribute to a rugged machine.

Left: Because of the highly loaded condition of the cruising engine in the multiengine, free-power installation, a high pressure ratio can be maintained in its compressor. The curve shows the 5:1 pressure ratio achieved by operating the compressor at only 15 per cent below its design speed (for 7:1 ratio).

Combustors suitable for use in line with the turbine are annular, can-annular, and multican. Where frontal area and weight are not critical, the multican arrangement provides the maximum of access to the combustion-chamber liners and fuel nozzles, while the provision of a bearing, its supporting structure, and its oil and air supplies in front of the turbine rotor is simplified.

Bearings and lubrication. Unlike aircraft engines, marine engines are seldom required to operate or start at ambient temperatures much below 40 F. Starter motors of much larger capacity can be provided, and salt-water coolers can be used in the oil system to remove heat generated in the bearings. Therefore the inherently greater power loss of the plain, sleeve-type bearing can be tolerated in the marine engine. Sleeve bearings possess advantages that heighten their resistance to fluctuating loads induced by wave slap and detonations occurring during naval actions.

The life of sleeve bearings is not limited by metal-fatigue phenomena. Sleeve bearings insure against extensive damage to the main rotor, in the event of bearing failure, since location of the shaft is retained. An axially split bearing configuration is possible which will facilitate inspection and removal of bearing shells or main rotor elements without removal of the engine from its mountings.

A bearing big enough to accommodate a turbine shaft is more than large enough to resist the maximum operating loads. Because lightly loaded sleeve-type journal bearings tend to become unstable at high speeds, giving rise to oil-film whip and whirl, an inherently more stable bearing than the simple sleeve type may be necessary. This may take the form of a lobed bearing, or a tilted-pad type. A flexible turbine design will specify the simplest type of bearing, but will provide for the easy substitution of more stable types during the development stage, if this should become necessary.

Miscellaneous features. The multiple-engine installation must employ a transmission which will permit any number of engines to drive the single output shaft. A clutch must be incorporated between each power turbine output shaft and the combining gear box, so that the turbine can drive, but cannot be driven from the gear. The engine control system must provide for automatic scheduling of engine operation. Whenever the need for increased power requires that an additional engine be cut in, the control must automatically initiate the starting cycle, energize and engage the clutch at the most suitable moment, and accelerate the gas producer to the required speed—and then execute a similar automatic cycle for shutdown, when reduced power is appropriate.

Large-diameter air-collecting scrolls and ducts are necessary between the heat exchanger and the engine, to minimize pressure losses. Flexible members must be provided in the ducting to allow for the inevitable misalignment of the components. The mountings of the engine components must not restrict their expansion relative to the cool structure of the ship, but must adequately locate them and resist the loads arising during operation.

The Installation

Normally, additional space must be provided between the engines and other components to insure accessibility. However, this provision does not detract significantly from the inherent compactness of the gas-turbine power plant, and the total space required is rather less than half that for a steam turbine and boiler installation. The specific weight is less than 7 lb per hp for a complete gas-turbine plant, including heat exchanger and transmission-reduction gearing, and designed for a life of 10,000 hr. Comparable figures for aircraft and steam-turbine installations would be 0.6 and 30 lb per hp.

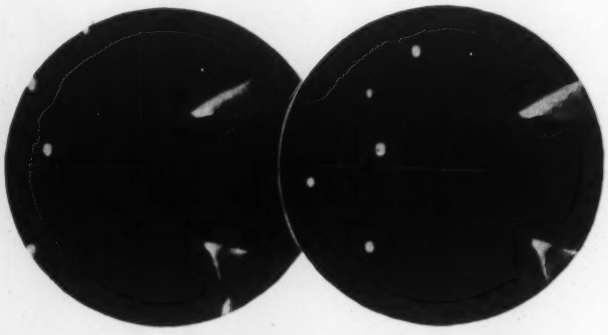
The engine family which has been evolved from the design philosophy detailed in this paper provides attractive power plants for such applications as landing craft, patrol vessels, mine sweepers, small and medium combat ships, escort vessels, and transports.

Briefing the Record

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Editor*

Left, actual photo of a "true tracking" radar presentation. The afterglow "trails" indicate the direction of harbor traffic. *Right,* artist's interpretation of what an experienced navigator "sees" in true tracking presentation.



Left, conventional radar presentation emphasizes "no traffic" land mass. Heavy traffic indicated at edge (west) of scope. *Right,* off-center radar feature retains land check points (east), but also brings onto scope ship traffic formerly unobserved.

True Tracking Radar

Sperry Gyroscope Company's "true tracking" radar, installed aboard the company experimental ship *Wanderer*, is the first and only adaptable marine radar equipment to combine off-center radar positioning and a panoramic presentation of all moving and stationary objects within range of a radar scanner.

True tracking radar virtually presents on the radarscope an aerial "motion picture" of vessels within range of the scanner. True tracking offers to the trained observer immediate differentiation between moving vessels and stationary objects. In a panoramic picture presentation, moving objects, including the radar-equipped ship, appear in perspective as moving blips of light with small, glowing, cometlike tails indicating course of travel. Stationary objects, such as land, docks, and buoys are clearly defined, stay fixed on the scope, and have no afterglow trails. Although this projection does not completely eliminate plotting, it enables the experienced navigator to instantaneously "see" and estimate true speed and course of all nearby vessels.

The off-center positioning device, also recently introduced, was initially developed for land-based stations and used for monitoring and controlling river, canal, and harbor traffic. This new feature, now available for shipboard use, allows navigators to position their ships electronically anywhere on the radar picture tube. Off-center positioning not only retains "close-in" definition and resolution of targets, but by moving land masses off the scope, the radar observer can scan greater area without changing the range scale. Off-center positioning provides an added safety factor for towboat operations requiring pin-point definition ahead of tow; provides coastal ships with sharp definition of shore check points, at the same time permitting the master to detect approaching vessels.

Off-center positioning control—a requirement for true tracking presentation—is a factory or field modification to Sperry's Mark III radar. True tracking is obtained by means of a small computer attachment which resolves ship heading and speed into proper signals.

Computing Satellite Path

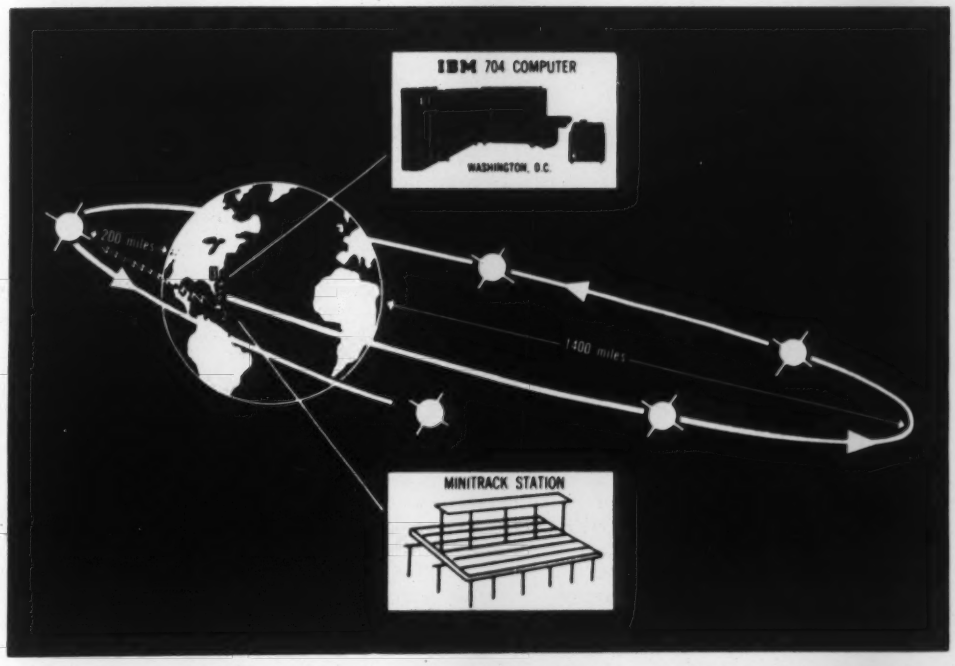
The Vanguard Computing Center, where high-speed electronic calculations will predict future orbits of U. S. scientific satellites, will be operated under a Navy contract by International Business Machines Corporation. An IBM 704 magnetic-tape-operated Electronic-Data-Processing System will be used.

One of the output devices which will be linked with this machine is the IBM 780 Cathode Ray Tube Output Display. This is a visual display unit which pictures the output of the computer in the form of graphs, geometrical figures, engineering symbols, or words and numbers—just as they might appear on the screen of a home television receiver.

Some of the toughest problems in establishing earth satellites for scientific research during the International Geophysical Year will concern proving that the satellites are orbiting, measuring these orbits, and subsequently predicting future orbits.

Initial U. S. satellites, planned for launching under Project Vanguard, will be 20 in. in diam and will speed at more than 18,000 mph in an elliptical course at altitudes of from 200 to 1400 miles above the surface of the earth.

U. S. Naval Research Laboratory scientists in the



Map shows man-made earth satellite at various positions in its orbit. Satellite in position at *far left*, 1, is sending a radio signal to Minitrack receiving station, 2. Signal is relayed to IBM 704 computer in Washington, D. C., 3. Computer processes message and predicts future orbit of satellite for other Minitrack stations throughout the world.

Vanguard program say that tracking this satellite will be as difficult as locating a golf ball traveling at the speed of sound at a 6000-ft altitude.

Initial acquisition and later tracking of the man-made moon by radio techniques will be assigned to a "Minitrack" system, designed by Naval Research Laboratory.

A subminiature radio transmitter with battery power enough to operate for several weeks will be installed in the satellite to reach antennas of ground tracking stations.

As the satellite crosses the area of these stations, they will measure its angular position by phase-comparison techniques, recording its "signature" automatically. Analysis of these signatures will give the complete orbital history of the satellite's passage. These data will be flashed to the Vanguard Control Center at the Naval Research Laboratory. Here they will be relayed to the Vanguard Computing Center for the complicated job of calculating and compiling satellite ephemerides (timetables of the expected locations of the satellite at regular intervals during its future life).

It will be these schedules, when signaled to optical tracking stations around the world, which will allow watchers to train their instruments at the right place and time for precise observation of the satellite.

Engine Balancer

TAKING an auto engine's "pulse" at any running speed permits measurement and correction of engine unbalance to a greater accuracy than heretofore possible.

Already in limited use on assembly lines, the General Motors Research Staff's Pulse Synchronized Unbalance Indicator, PSUI, is scheduled for expanded service.

The PSUI balances an engine faster than any former type of General Motors Research balancer, and is smaller and less expensive than earlier types.

The new PSUI unit is mounted in a control cabinet and is capable of detecting both amount and location of any engine unbalance, both at the flywheel and the fan-belt pulley at the front end of the crankshaft.

When an engine reaches the end of the assembly line, it is put on a stand for its final "hot" test. Seismic magnetic pickups at each end of the engine detect unbalance. Timing or synchronized pulses from the ignition are employed to determine location of the unbalance.

When the engine gets its final run-in adjustments at various throttle settings, the operator of the new PSUI unit simply checks two pairs of dials.

Each set of dials informs him simultaneously of both the amount and location or angle of unbalance at one or both ends of the engine.

Both the flywheel at the rear, and the fan-belt pulley at the front of the engine have evenly spaced holes near their outer rims for canceling out unbalance simply by riveting small weights in the hole opposite the "heavy" side of the flywheel or fan-belt pulley.

The complete engine receives a "totalizing" or over-all balance to cancel out any "stacking" of unbalance by its individual rotating parts.

The improved quality of this new balancing technique is due in part to the elimination of other rotating equipment that was required on earlier balancing machines. The same technique of electronic balancing appears feasible for other specialized balancing problems of individual engine parts.

Numerically Controlled Milling Machines

Two significant "firsts" in numerically controlled machines for automatically milling complex airframe spar and skin sections in both plane and missile production have been achieved at the Fond du Lac, Wis., plants of Giddings & Lewis Machine Tool Company.

The Variax, first variable-axis airframe profile-milling machine to operate solely by magnetic-tape commands has been shipped to Lockheed Aircraft Corporation, Burbank, Calif.

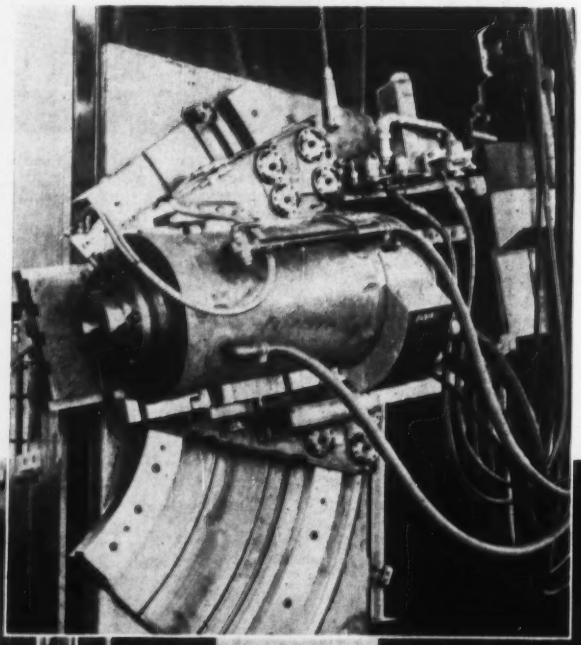
Simultaneously, final cutting tests and approval by defense department and aircraft industry technical teams have been given the first regular production model spar and skin-milling machine ever to be equipped with numerical control. Shipment of this machine will be made shortly to The Martin Company, Denver, Colo.

Both machines represent initial deliveries, in their respective design categories, on a quantity order by Air Materiel Command of the United States Air Force. Both also feature the Giddings & Lewis pioneered Numericord system of magnetic-tape control over all machining functions whereby decimal, numerical data, programmed directly off part drawings, are converted electronically into time-motion co-ordinated electrical machine-command signals. See August, 1955, issue of MECHANICAL ENGINEERING, pp. 683–685.

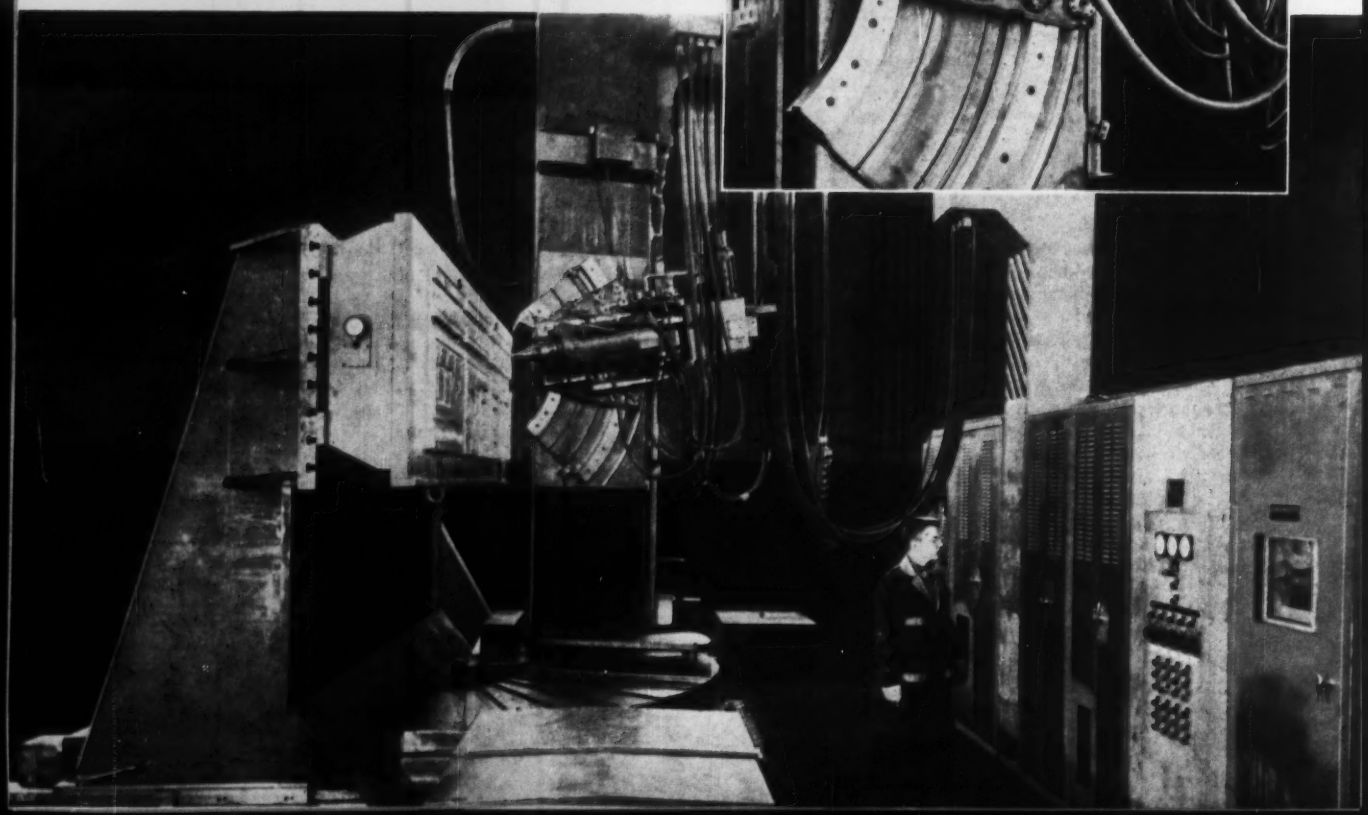
Variax machines fully match airframe structural progress in their ability to mill increasingly intricate designs at high rates of production. Such airframe designs often involve profiles derived from loft data, generated step cuts, continuously variable angles, pocket and multiple recess milling, internal variable angles, and machine control governed by element-line geometry—operations completely out of the question for conventional milling machines.

Variax is ideally suited to production machining of such parts, whether the material be ferrous or nonferrous, billet stock or forgings, generating a correctly finished surface that does not require additional "blending" or hand finishing. This is accomplished by machining with either the flat end surface of an "end mill" type cutter, or the side of such cutter, or a combination of both cutting surfaces, when the configuration permits. By utilizing the combination of movements available in the Variax head, it is possible to position the tangent cutting line of the cutter coincident with the element lines which generate the surface geometry of the workpiece.

Swivel of the head, on its segmental saddle ways, for a 5-axis Giddings and Lewis numerically controlled Variax profile-milling machine. Continuously variable angles as well as other increasingly intricate designs can be milled.



Variax 5-axis machines provide wide-angle swivel of the machine column and of the head on its segmental saddle ways, in addition to column and head travel, and depth control provided on the 3-axis models. All machine movements are numerically controlled for completely automated operation.

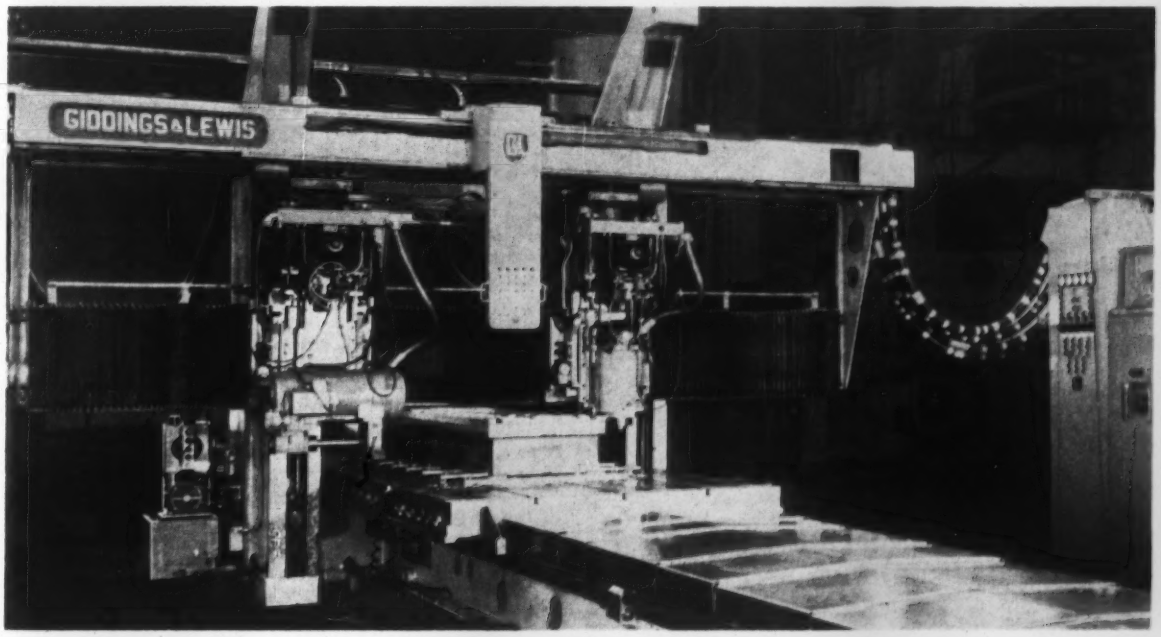


Movements of Variax machines are derived from a combination of (*a*) horizontal movement of the column upon its runway, and (*b*) vertical movement of the saddle on its column ways for 360-deg-path control in the plane of the angle plate where the work is mounted. In addition, the company's 5-axis machines provide (*c*) depth motion through movement of the head along the spindle axis, (*d*) head swiveling in the saddle plane on segmental ways to achieve a transverse-tilt function, and (*e*) column swiveling, on an axis coincident with the extension of the cutter center line, to give longitudinal tilt, making up angular motions to the spindle that have a common locus point on the spindle axis. These provide a programming plane where zero movement of the cutter axis exists during angular displacements of the tool, eliminating corrections and compensations that would otherwise be necessary.

On 5-axis Variax machines, all cutter-axis motions are infinitely variable and completely co-ordinated by numerical programming which defines continuous control of all movements.

The machine being readied for shipment to The Martin Company is a standard design Gidding & Lewis spar and skin-milling machine, equipped with the company's exclusive Numericord system of magnetic tape control. The exceptionally rigid, closed rectangular arch and rail design permits interchanging ferrous and nonferrous cutting heads supplied with each machine, making it quickly adaptable to the work required on either class of material.

The spar and skin-milling machine, equipped with numerical control, has been approved by the Air Materiel Command for shipment to The Martin Company's Denver, Colo., missile plant. Both horizontal and vertical heads are mounted for dual-type profiling. The machine is supplied with an additional heavy-duty milling head of each type, permitting the widest flexibility in machining setups, and quick adaptability to work on either class of material.



High-Efficiency Fly-Ash Collectors

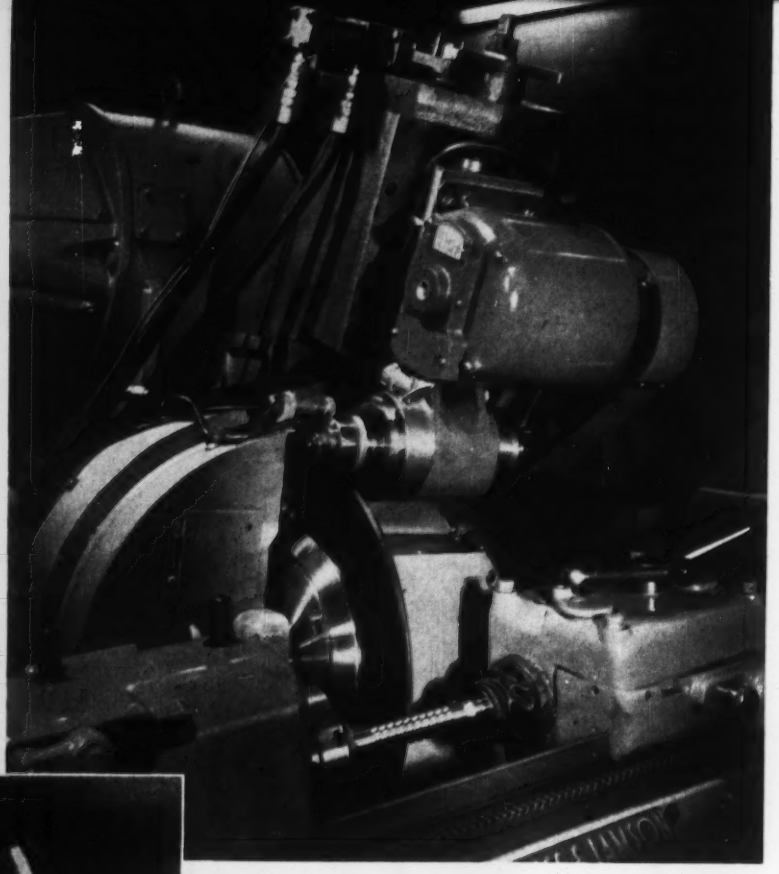
Two of the largest collectors ever designed for the high-efficiency removal of fly ash will be incorporated into the Astoria and Arthur Kill stations of the Consolidated Edison Company of New York, N. Y. Essentially identical, with the exception of precipitator outlet flues to the stack, the equipment is expected to go into operation at the Astoria station during 1958 and at the Arthur Kill station during 1959, according to present schedules. Each Research-Cottrell fly-ash collector will clean 1,400,000 cfm of flue gas at 300 F from a Babcock & Wilcox reheat boiler that will generate 2,500,000 lb of steam per hr. The design efficiency of these combination mechanical-electrostatic precipitators is higher than any similar fly-ash collectors previously ordered by Con Edison.

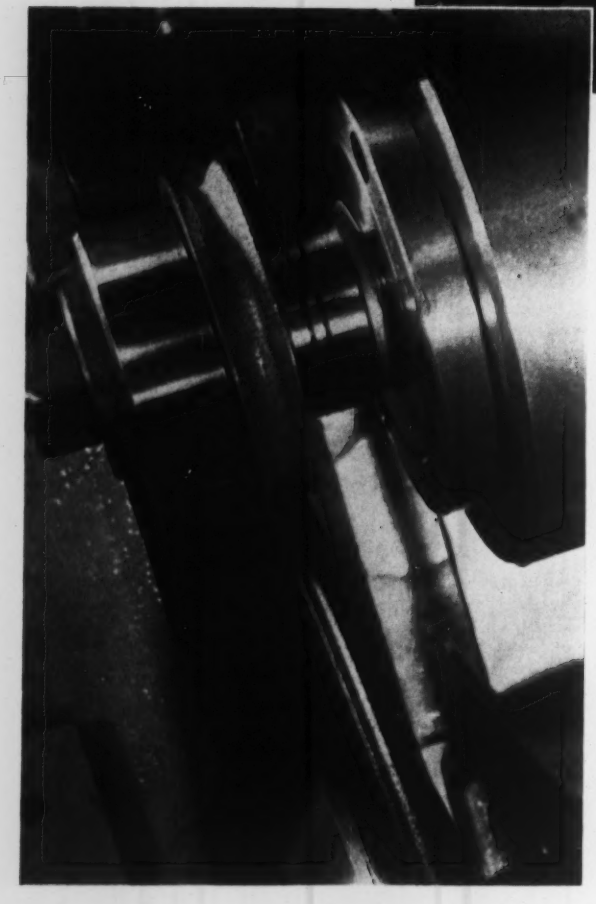
The fly-ash-collection system, designed and to be installed by Research-Cottrell, Inc., Bound Brook, N. J., will consist of a standard combination design incorporating a double-deck mechanical-collector arrangement preceding the electrostatic precipitator. The precipitator will have complete top rapping of both collecting and discharge electrodes. The boiler at each plant will have two collectors of four units each, each unit consisting of a mechanical collector followed by four sections of electrostatic precipitators in series. Each of these sections will consist of 28 ducts, each 20 ft high by 22 ft long.

Perpetual form control, through the use of a motor-driven cutter in contact with the grinding wheel, makes possible the complete automation of production grinders. The complete setup of a Jones & Lamson 6 × 36-in. thread grinder with a cemented-diamond-particle cutter and perpetual-form-control dressing mechanism is shown in the *photo to the right.*

On the *opposite page,* a simple CDP cutter is mounted in a J & L perpetual-form-control feed cylinder, here removed from the machine. The entire cylinder feeds forward keeping the cutter in contact with the wheel. Pressure jet cooling is used.

Below is a close-up of the Koebel cemented-diamond-particle cutter which dresses the wheel. Thousands of fine diamond particles are embedded in the powder-metal cutter body.





Perpetual Form Control

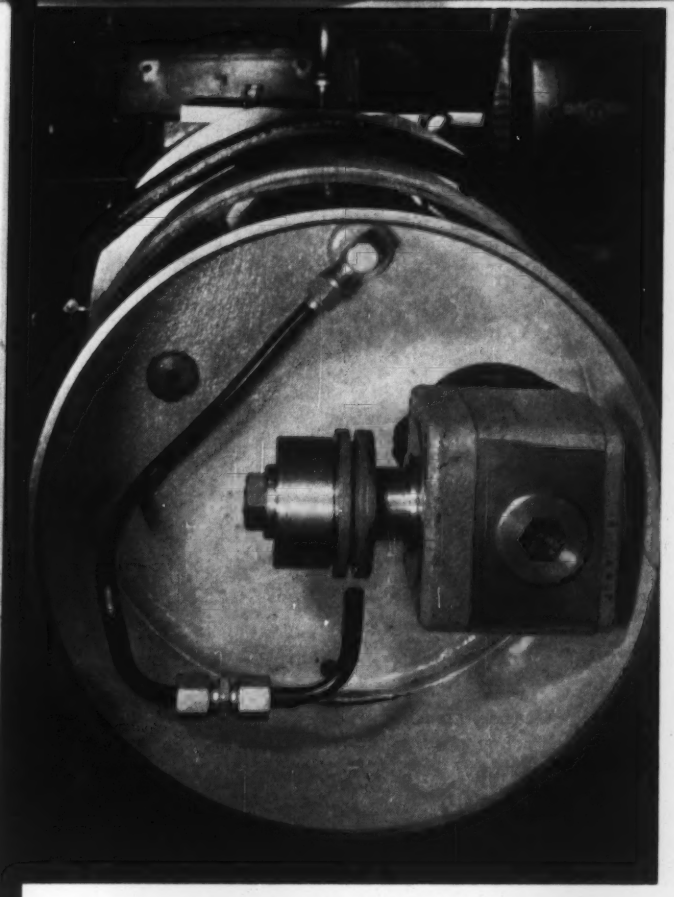
COMPLETE automation of production grinders is made possible by perpetual form control of grinding wheels. A motor-driven cutter in contact with the grinding wheel, which continuously shapes and sizes the wheels, maintains an accurate form in spite of wear.

Jones & Lamson Machine Company, Springfield, Vt., and Koebel Diamond Tool Company, Detroit, Mich., have been developing the process and necessary equipment over the past five years.

Hundreds of thousands of parts can be ground with a single cutter with no change in accuracy, although a number of grinding wheels are worn out. Grinding wheels can also be shaped directly from the solid when this is desirable.

The cutter is the culmination of efforts by the Koebel Diamond Tool Company to develop methods of using diamonds of smaller size. The patenting of the powdered-metal technique for mounting diamonds in 1930 was the first big step in achieving the process. Diamond powder can be used with this method of mounting, and the different characteristics of the individual diamond particles are compensated for in the average dressing action of the many points. It is no longer necessary for the operator to use judgment in adjusting the dressing action to accommodate the unique characteristics of the individual diamond.

It will be possible to utilize man-made diamonds or other "superhard" materials as substitutes for natural diamonds, assuming that they will be offered in fine particle sizes.



Privately Owned Standards Laboratory

DESIGNED to provide a convenient service supplementing and extending that of the National Bureau of Standards, the IT&T Standards Laboratory at Clifton, N. J., is active in the entire field of primary metrology. The new facility, for testing master gages and master electrical instruments, is one of the best equipped privately owned installations of its kind in the world.

The laboratory is a room within a room, isolated from vibration, shock, and the environmental conditions of the Federal Telephone and Radio Company plant in which it was built. The floor is a slab of reinforced concrete, 12-in. thick, floating on a vibration-absorbing material that, in turn, is in a concrete-lined pit. Flexible material isolates the floor from the walls and plant floor. Air conditioning with special filtering maintains the mechanical laboratory at 20 C and the electrical laboratory at 25 C, the recognized standards for those types of measurements. Positive air pressure is maintained so that all leakage is to the outside, preventing dust from entering

The mechanical laboratory checks all master gages—such as gage blocks, threaded and plain set plugs and ring gages, thread-measuring wires, master gears—certifying them for dimensions, surface roughness, and hardness (for hardness-testing gages). This service and the comparable service for electrical master instruments are available to private companies, to organizations such as universities and scientific foundations, to U. S. Government agencies, and to International Telephone and Telegraph system companies throughout the world.

Automated Air Defense

THE first operational ground-control intercept system of the Air Force to work on the principle of electronic automation has been developed in the Electronic Research Laboratories at Columbia University. An analog computer and other components automatically guide American interceptor planes to approaching enemy aircraft, furnishing signals which are automatically incorporated into the fire-control system of the intercepting aircraft.

The Columbia computer performs the basic tracking and computing required in an over-all system which receives data from long-range radars, tracks potential hostile planes, and then automatically directs interceptors to the oncoming target for the kill.

If desired, the signals may instead be given verbally to the pilot.

The computer and its storage and display components are known informally in the Air Force as the "Ragazzini Computer" or the "Ragatrack." It is named for John R. Ragazzini, professor and executive officer of the Department of Electrical Engineering at the Columbia School of Engineering.

General Electric's Heavy Military Electronic Equipment Department at Syracuse, N. Y., is now producing the system in quantity for the Air Force.

Element 102 Discovered

NOBELIUM is the name proposed for element 102 by the Britons and Americans who participated with Swedish scientists in the research that led to its discovery at the Nobel Institute for Physics, Stockholm, Sweden.

The joint international research team included scientists from the Chemistry Divisions of the Argonne National Laboratory, Lemont, Ill., the Atomic Energy Research Establishment, Harwell, United Kingdom, as well as staff members of the Nobel Institute for Physics.

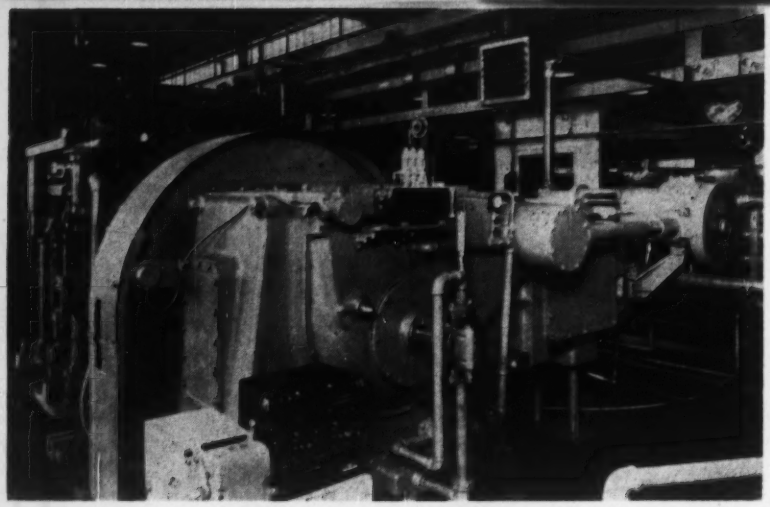
The new element was found by bombarding curium, which is element 96, with carbon ions accelerated in the cyclotron at the Nobel Institute, which was more effective than the one at Argonne. Argonne provided the very rare isotopes of curium used in the experiments, which were shipped to Harwell, where they were prepared for the experiments.

Harwell also provided carbon-13, which was used as the bombarding particle. The Nobel Institute provided the cyclotron, some special equipment, and a staff of physicists, chemists, and technicians.

The element was recognized by its unique nuclear properties, such as its half-life and radiations, and by its chemical properties typified by its behavior on an ion exchange resin. The possibility that element 102 might be thorium of a type produced at the University of California Radiation Laboratory, which had similar properties, was considered. Additional experiments proved that the element was new, and not thorium.

This isotope of element 102, thought to have an atomic mass number of 253, is very unstable, has a half-life of about 10 to 12 min, and emits alpha particles.

This is the fourth element discovered since 1955 when elements 99 and 100, Einsteinium and Fermium, were found in the debris of the first H-bomb, and element 101, Mendelevium, was discovered in the laboratory.



This expansion engine can be used in the production of liquid oxygen, nitrogen, and other gases, and in the separation of gases by liquification at temperatures as low as − 300 F

Expansion Engine

An expansion engine for gas liquefication service capable of handling temperatures as low as −300 F is announced by The Cooper-Bessemer Corporation, Mount Vernon, Ohio.

Designed to handle inlet pressures up to 3000 psig, the new expansion engine meets the requirements for industrial refrigeration, liquefication of gases, and separation of gases by liquefication.

A reciprocating-piston type machine, the expander engine generates shaft horsepower as a useful by-product. Converting the energy of gas expansion through a piston, cylinder, and crankshaft, the expander engine can be coupled directly to a compressor drive shaft, an electrical generator, or a brake as desired. An air flow of 250 lb per min at 3000-psig inlet pressure and 250-psig outlet pressure develops over 200 bhp at the crankshaft. Regulation of air or gas capacity can be easily controlled to suit the needs of any particular plant.

The expander engine's wide range of flows and pressure ratios is accommodated through a variable cutoff. In operation, gases are admitted and discharged through timed inlet and exhaust valves. Variable cutoff from zero to 50 per cent of stroke is provided by the inlet cams.

Frosting of springs and associated valve-operating mechanism is minimized by totally enclosing valve gear for pressurization with nitrogen or other gases if that is desired.

The Cooper-Bessemer JX-14 expander engine operates in conjunction with either centrifugal compressors or reciprocating compressors.

Widest application of these combinations is anticipated in the cryogenic fields, namely, the production of liquid oxygen, nitrogen, and other gases, and in the separation of gases by liquefication.

Boiler Circulation Theory

A major research project, relating to the fundamentals of circulation theory in high-pressure boilers and other types of evaporative heat exchangers, is being sponsored by the Water-Tube Boilermakers' Association of London with the actual research work being carried out by the Department of Engineering in the University of Cambridge.

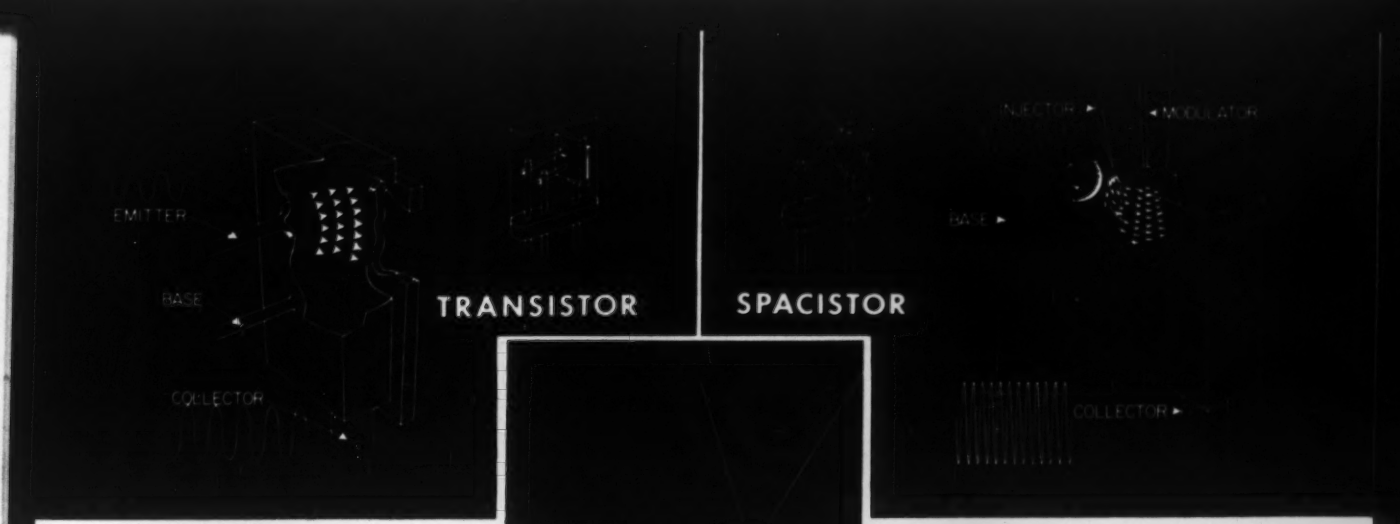
The primary object of the research is to establish experimental data relating to the pressure drop and flow conditions of a steam-water mixture flowing along heated and unheated pipes at pressures up to the critical. Studies are being made of the effect of several variables, including pressure; heat-input rate; internal diameter, and inclination of test section; the velocity of the water entering the heated test section; and the dryness fraction of the emergent steam-water mixture. Little information on this subject is available, but it is a field of increasing importance, particularly in the design of high-pressure boilers for power stations and of heat exchangers for nuclear plants. The results may also be applicable to the design of water-tube boilers for marine use.

While the research is not expected to revolutionize the design of high-pressure boilers, the results obtained should provide a scientific basis for the assessment of present design methods, and so possibly lead to improved designs.

Experimental work begun at Cambridge in 1949 confined to a simple U-circuit at atmospheric pressure, without steam production in the riser, resulted in a unification of the existing, but previously conflicting, theories on the subject known as the "hydraulic," "thermodynamic," and "expansion" theories of circulation.

This theoretical analysis was published in a paper entitled "Research Into the Fundamentals of Boiler Circulation Theory," by R. W. Haywood, presented to the General Discussion on Heat Transfer, organized jointly by The Institution of Mechanical Engineers and The American Society of Mechanical Engineers, and held in London in September, 1951. Because of the limitations of the experimental work undertaken at Cambridge in the absence of steam production, the Association agreed to sponsor an experimental research project proposed by the University as an extension to the existing work. Most of the available data on this subject has been obtained at pressures of less than 100 psi, but the Association-sponsored project, essentially fundamental in conception, is expected to provide much-needed data over a wide range of pressure levels.

The various developments and a method evolved for determining the flow conditions from gamma-ray scanning have been the subject of short individual reports to members of The Water-Tube Boilermakers' Association. The results of the first full series of tests, already completed on a 1-in-bore horizontal test section at five pressure levels—250, 600, 1250, 2100, and 3000 psi—will be published in due course, together with the results that are obtained from other tube sizes at the various inclinations.



In a typical transistor, *above,* a negative voltage is applied between emitter and base, which causes a flow of electrons between the emitter and the positive collector. The small fluctuating signal to be amplified is applied between the emitter and base, causing the negative emitter voltage to fluctuate accordingly. The transistor amplifies because the input resistance is lower than the output resistance while the input current is substantially equal to the output current. The result is a net signal power gain.

Experimental assembly of Raytheon's spacistor, *left;* functional diagram, *above.* A voltage applied between base and collector produces high electric field and virtually no current. A voltage, applied to the injector, causes electrons to enter the region of high field. The electrons flow extremely rapidly to the collector contact. This flow is modulated by application of a signal to the modulator as shown. Since the modulator draws only a negligible current, while causing the current between injector and collector to fluctuate, amplification results.

"Spacistor" Semiconductor

A MAJOR step forward in the art of amplifying or boosting electrical energy is claimed by physicists of Raytheon Manufacturing Company, Waltham, Mass.

The semiconductor device, called a spacistor, which uses a wholly new principle, is as small as a transistor and operates electrically like a vacuum tube.

Still in the research stage, spacistors promise two major advantages over today's best transistors. Amplification at frequencies up to 10,000 megacycles—as much as 50 times higher than transistors—is predicted. Because spacistors can be made from materials unsuited for transistors, they are expected to operate at temperatures as high as 500 C, or more than double today's germanium or silicon transistors.

Disclosure of the spacistor was made by Hermann Statz, Robert Pucel, and Conrad Lanza in a paper presented at the recent semiconductor session of the IRE and the AIEE in Boulder, Colo.

Invented after two years of intensive research, the spacistor may require three to five years more research and development before it will become commercially available.

Among present electronic equipment expected to benefit materially from the spacistor, are guided missiles and rockets, radars, communications equipment, and TV sets.

The spacistor retains many transistor advantages. It operates on a fraction of vacuum-tube power, having no filament to heat or burn out. Also, it can be tightly packaged in minute assemblies.

Closed-Circuit 3-D Color TV

CLOSED-CIRCUIT three-dimensional color television has been developed by the General Electric Company for remote serving of reactors used in development of a nuclear aircraft-propulsion system.

The color stereo system was developed to permit use of color-coded parts in reactor components, and to provide the degree of precise depth perception required for their correct positioning. The new system makes remote adjustments of parts much easier than by black and white two-dimensional TV.

Developed for the Company's Aircraft Nuclear Propulsion Department, ANPD, it is for use at the AEC's test site, Idaho Falls, Idaho. ANPD is developing an aircraft nuclear propulsion system under contracts with the Air Force and the AEC.

The new General Electric TV system was described by company engineers as "currently not feasible for the American living room" but suited for adaptation to other uses for closed-circuit television.

The observer's viewpoint is effectively transferred to that of a camera equipped with a dual-optical system having perspective similar to that of the observer's eyes.

However, instead of presenting the pictorial image to two sensitive surfaces, as the human eyes do, the stereo-TV system presents two images to a single sensitive surface, a television tube, on a time-sharing basis.

The frequency of the time sharing is at the picture rate of the television system, in this case, 90 pictures per sec. By alternating 45 pictures per sec for each eye, engineers have eliminated any objectionable flicker, which might otherwise be present.

A rotating shutter in the special color-TV camera alter-

nately transmits the scene as viewed from two points to the camera's tube.

In the viewing console, light from the television image formed on the cathode-ray tube passes through a drum composed of alternate segments of polarizing filters with axes of polarization at right angles to each other. The drum revolves in synchronism with the television frame rate of the camera and polarizes alternate frames vertically and horizontally. Thus all left-eye pictures are polarized in one direction and all right-eye pictures are polarized in the other direction.

An observer viewing the screen—with his polarized spectacles—sees the left optical path with his left eye and the right optical path with the right.

Laboratory tests were conducted on the closed-circuit system using 250 ft of cable, but the cable can be lengthened to any required distance or replaced by a radio link without losing clarity, color, or three-dimensional effect.

Correction

By omission of a phrase in the article on the "Supercritical Generator," p. 660 of the July, 1957, issue of MECHANICAL ENGINEERING, General Electric was credited with designing and building the steam generator. The last sentence of the paragraph beginning "Philo 6," should have read, "General Electric designed and manufactured the turbogenerator, and Babcock & Wilcox designed and built the steam generator."

Tape Cable

ELECTRICAL cable in tape form with polyester insulation, trade-marked Tape Cable, has been introduced by Tape Cable Corporation, Rochester, N. Y.

Typically only 0.008 in. thick with 0.0015-in-thick, 0.030-in-wide flat copper conductors, it is available in nine standard sizes in lengths up to 1000 ft with 9 to 50 parallel conductors spaced 0.100 in. center to center in accordance with the recommended RETMA grid pattern for printed wiring, permitting use with printed-circuit connectors. Parallel circuitry eliminates the need for color coding.

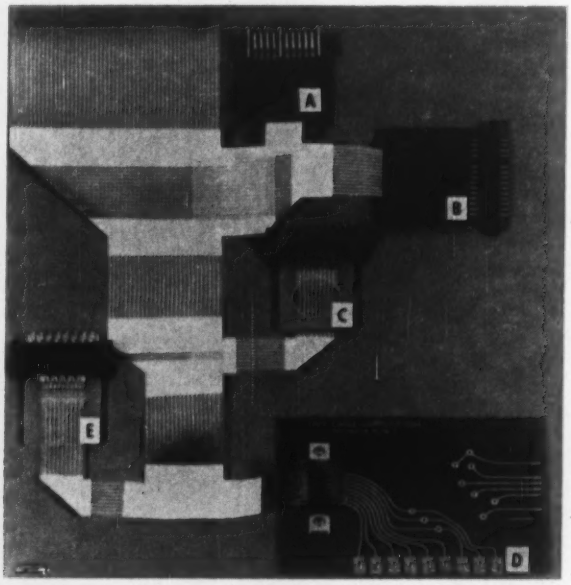
The Tape Cable has a high conductor density, 1160 conductors per cross-section sq in. as compared with only 225 for ordinary cable having number 22 wire insulated with 0.010-in. wall. Weight is only a fraction of standard insulated cable, a 100-ft roll of 50-conductor Tape Cable weighing only $2\frac{1}{2}$ lb.

Conservative ratings of 1 amp in free air and 300 volts with a maximum cable thickness of only 0.011 in., and low interconductor capacitance of less than 5 mmf per ft between conductors make it ideal for high-frequency applications, and adequate for most signal-circuit requirements. Interconductor capacitance can be reduced to under 1 mmf per ft in free air by grounding alternate conductors.

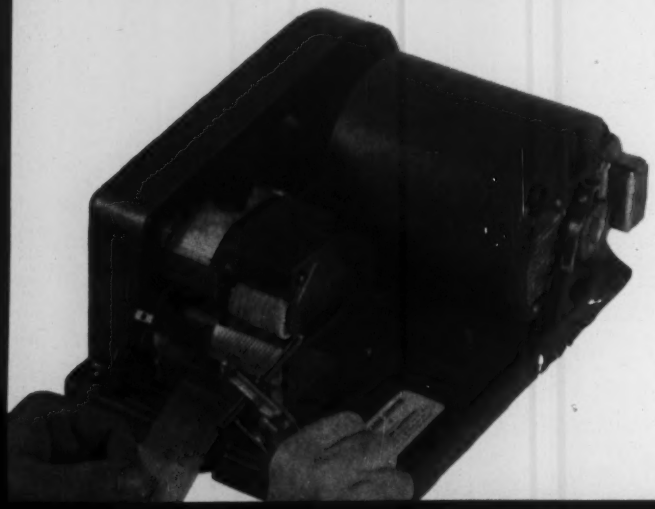
Phenomenally high flex life permits successful use in applications requiring continuous flexing on a radius of $\frac{1}{4}$ in. Tensile strength is 80 lb per in. of width, greater than that of the soldered connections, and strain relief is provided by one of several means.

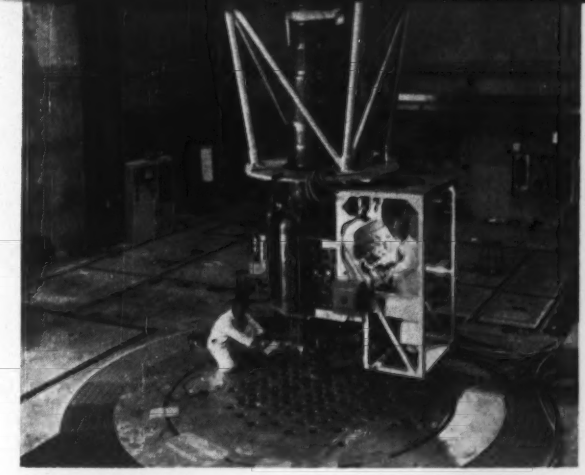
All or any number of the conductors in a single cable may be stripped readily and easily in one operation by a pair of opposing high-speed glass-fiber wheels. The stripped conductors of each cable may be handled as a unit, and two or more cable ends brought together, dip soldered and insulated with tape to form a splice.

A 50-conductor Tape Cable harness may be connected in a number of ways: A, 9-contact Tape Cable plug with rubber sleeve, wedge strain relief, and cinch connector; B, 14-contact Tape Cable plug with rubber sleeve, wedge strain relief, and Amphenol connector; C, 9-contact Elco plug and connector; D, 9-contact printed-circuit board, with bar strain relief, and Timmerman nuts for making wire connections; E, 9-contact Elco plug and connector. ▶

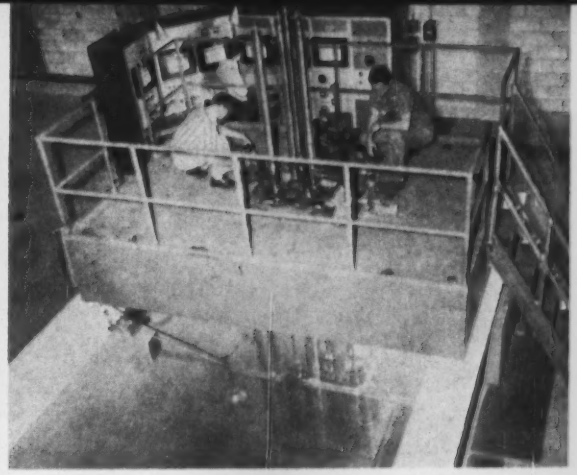


Tape Cable may be stripped rapidly with a TCD-1 Tape Cable Stripper. Two motor-driven glass-fiber wheels remove the insulation and polish the conductors. The gap between the wheels is adjustable, permitting various thicknesses of insulation to be removed. Tape Cable may be stripped on one or both sides for soldering. ▼





Base plate of the Engineering Test Reactor Critical Facility. Round tubes with pointed tips are ends of containers for neutron detectors which can be raised or lowered in tubes. Square tubes with slots are bottom ends of shim-rod guide tubes, to which are attached shock absorbers and seat switches to indicate when shim-safety rods are seated.



The ETRC is a low-powered reactor designed to provide information necessary to the safe operation of the ETR. The small motor in right foreground actuates single regulating rod, which is servo-operated. Entire core of the ETRC is submerged in 19 ft of water below the bridge in a 20-ft-deep steel-insulated concrete tank, and is a duplicate of the ETR core.

Nuclear Briefs

▶ ETR Critical Facility

The Engineering Test Reactor Critical Facility, ETRC, a 50-kw swimming-pool-type light-water-moderated and convection-cooled thermal reactor began operation in May.

Located in a building adjacent to the Engineering Test Reactor, ETR, the ETRC was designed, built, and is operated by Phillips Petroleum Company for the AEC. It furnishes data necessary to the safe operation of the parent ETR, also to be operated by Phillips.

The ETRC is a full-scale mockup of the core and reflector of the ETR which will go critical this fall. Purpose of the ETRC is to obtain data necessary to the safe operation of the ETR by means of reactor physics measurements and engineering measurements which will assist in the design of experiments for the ETR, the world's largest irradiation test facility.

Most critical experiments do not require power beyond a few watts. Without the ETRC, a major portion of the ETR's operating time would be used for the calculation of neutron densities, heat-transfer conditions, and other behavior characteristics. It is estimated that the ETRC will pay its $345,000 cost in little more than a year's time by keeping the ETR free to run at full power.

▶ Export Reactor

A proposed basic design for a nuclear steam-generating system was demonstrated by The Babcock & Wilcox Company to 60 industrialists and government officials of the Euratom countries—Belgium, France, Western Germany, Italy, Luxembourg, and the Netherlands—who recently toured America's principal nuclear facilities under the auspices of the AEC and the Department of State.

The design, which would satisfy the requirements of electric utility companies of foreign nations now in the market for atomic power plants, could be modified to suit individual installations. The thermal energy nuclear reactor, using light water as moderator and coolant, would produce nearly 2,000,000 lb of steam per hr, sufficient for a 133,000 electrical kw utility plant.

▶ SRE Produces Electricity

Electric power was produced for the first time July 12 by heat from the Sodium Reactor Equipment about 30 miles northwest of Los Angeles, Calif. The SRE was designed and built for the AEC by Atomics International, a division of North American Aviation, Inc.

The Southern California Edison Company has installed electrical-generating equipment adjacent to the nuclear reactor to convert reactor heat energy, which the company purchases from the AEC, to electricity.

Following test of all components, the reactor plant will be operated at full power late this year. The reactor is designed to produce 20,000 kw of heat to generate approximately 6500 kw of electricity. In the first test the generator operated at a level of about 1000 kw of electricity. The generating facilities will operate intermittently, depending upon the experimental operation of the reactor.

The Edison Company will share with other power-generating organizations the information it gains from the SRE.

▶ Westinghouse Reactor Evaluation Center

Westinghouse Electric Corporation has established a Reactor Evaluation Center on an 850-acre tract, 29 miles southeast of Pittsburgh, Pa.

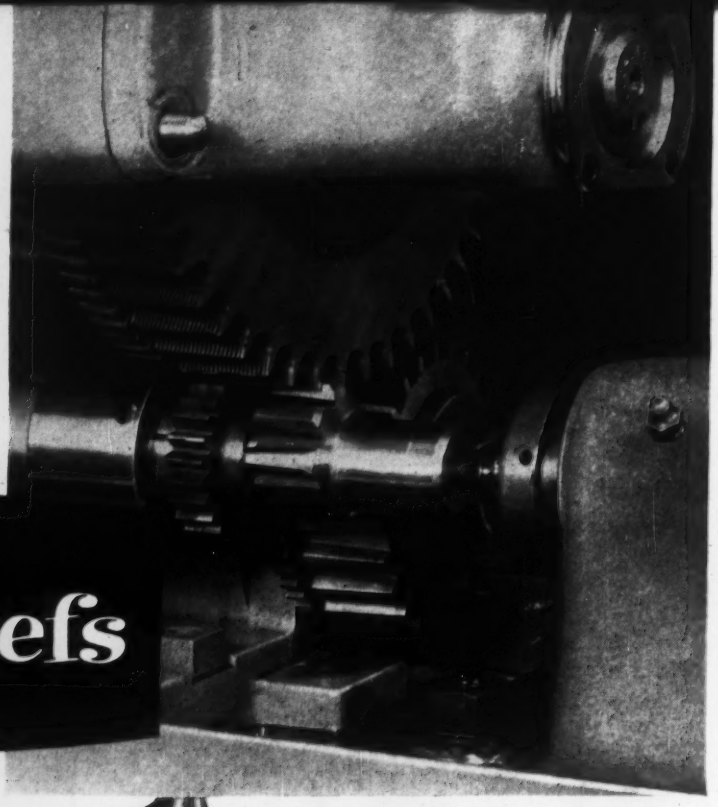
Charles H. Weaver, Mem. ASME and vice-president in charge of atomic-power activities for Westinghouse, said the center will be used "to check out the reactor calculations and the value of various types of control rods in prototype cores for power reactors."

One of the first activities in the new center will involve testing the core for the Westinghouse Testing Reactor, WTR, the first industry-owned nuclear materials testing reactor scheduled for completion in late 1958 on the same 850-acre site.

The WTR will operate in the range of 20,000 kw or above and will be used to test materials under conditions similar to those in a power reactor.

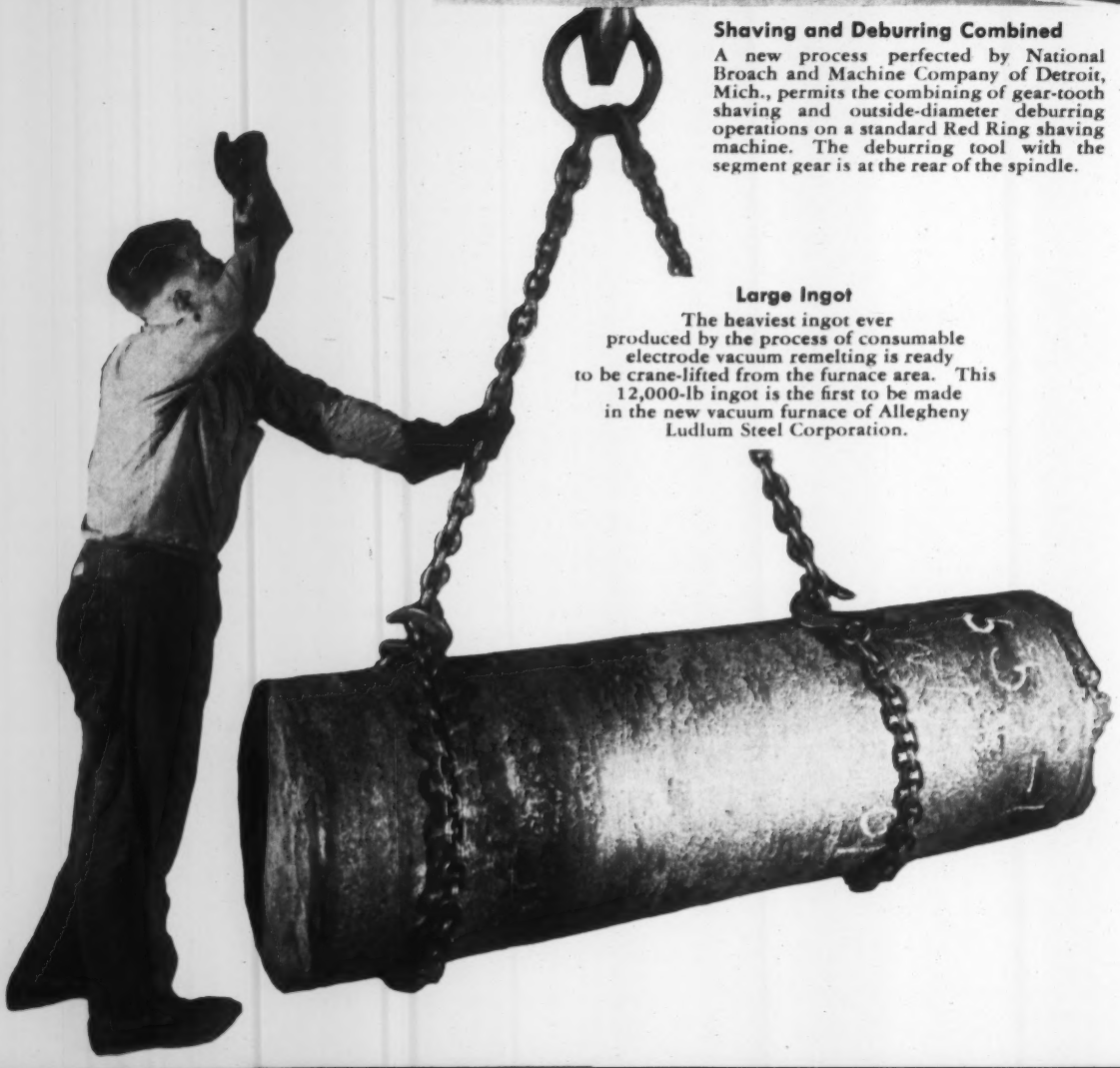
Heretofore, private industry has had to depend on government facilities, such as the AEC's Materials Testing Reactor in Idaho, for development work on fuel and materials for nuclear power plants.

Photo Briefs



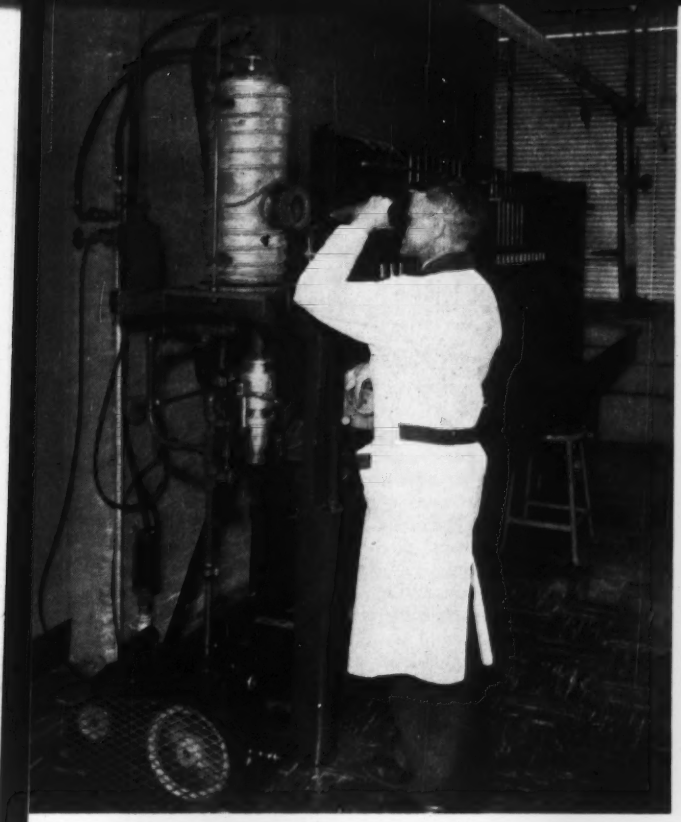
Shaving and Deburring Combined

A new process perfected by National Broach and Machine Company of Detroit, Mich., permits the combining of gear-tooth shaving and outside-diameter deburring operations on a standard Red Ring shaving machine. The deburring tool with the segment gear is at the rear of the spindle.



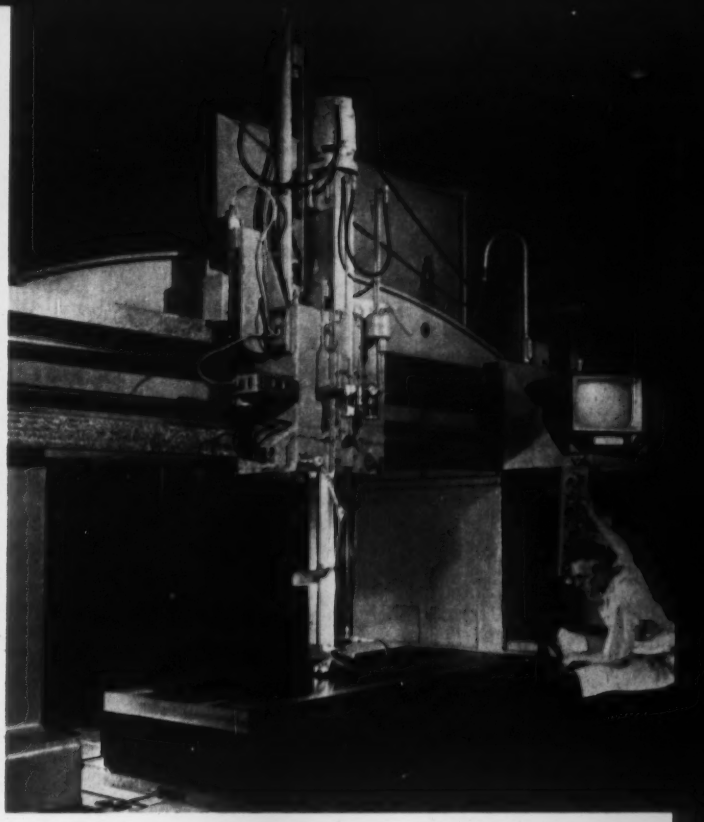
Large Ingot

The heaviest ingot ever produced by the process of consumable electrode vacuum remelting is ready to be crane-lifted from the furnace area. This 12,000-lb ingot is the first to be made in the new vacuum furnace of Allegheny Ludlum Steel Corporation.



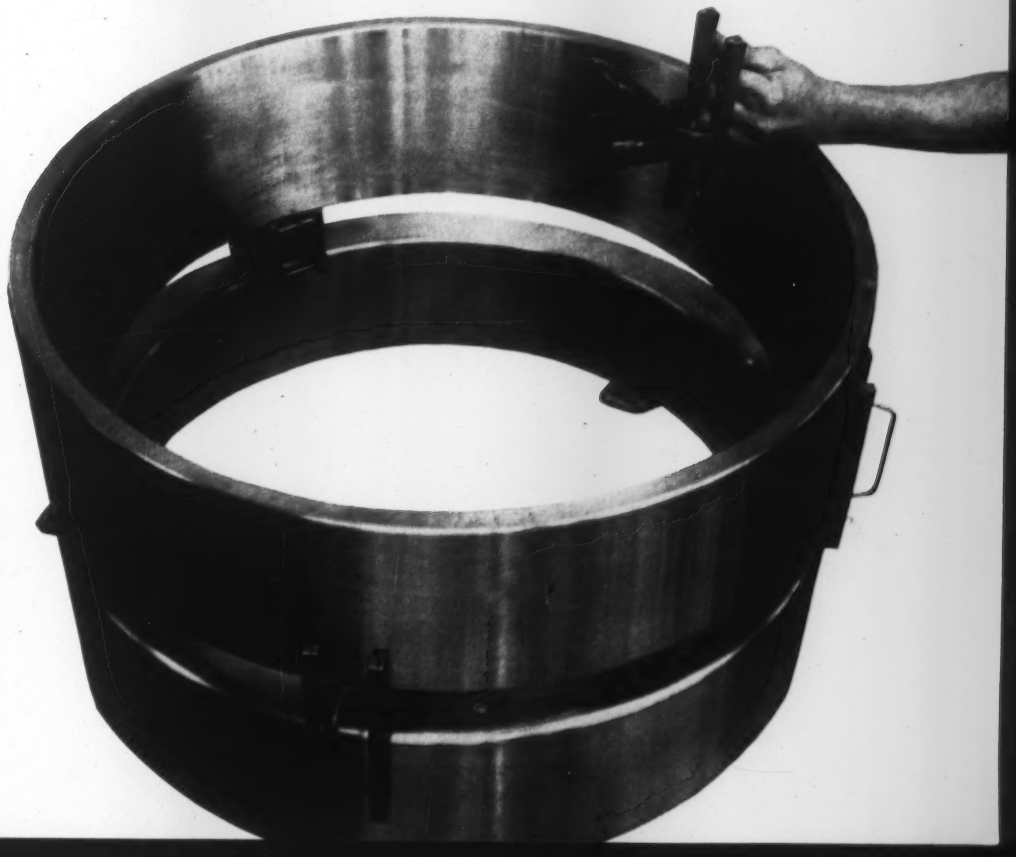
Vacuum "Life Test"

Life in a vacuum—for resistance wire, that is—being checked with an optical pyrometer by a research technician at Hoskins Manufacturing Company, Detroit. Company engineers designed and built this special vacuum-atmosphere "life test" equipment—which tests multiple resistance wire specimens in vacuum as low as 0.5 micron, throughout a resistance heating test range of 1600 to 2600 F.



Television for Accuracy

Television is used to advantage in this special die-layout machine. Installed at Alcoa's Cleveland works, it achieves pushbutton-controlled accuracy in laying out forging dies. Auxiliary tools that can be used in the spindle include pencil type scribers, air-pressure regulated rolling scribers, transit-type optical alignment telescopes, vernier scribers for large radii, and others.



Handling Device

A simple locking and separating device is used by Timken in the handling of its large finished cups. The device makes it possible to stack one large cone on top of another without danger of slipping. Without clamps a sudden stop or quick turn could cause them to slip due to the smooth surfaces of the front and back faces. Brass shoes on the locking device prevent nicking or scratching of the piece.

European Survey

Engineering Progress in the British Isles and Western Europe

J. Foster Petree,[1] Mem. ASME, *European Correspondent*

Power-Operated Trailer Coupling

Oil companies have been responsible for many innovations in the design of heavy vehicles for special purposes. One of the latest is the result of a collaboration between the engineers of the Shell Petroleum Company and those of the Douglas Equipment Company, of Cheltenham, England, in the design of a new "fifth wheel" trailer coupling for a Douglas "Tugmaster" tractor. The special feature is that the coupling is mounted on lifting beams hinged to the main chassis frame and arranged to be raised and lowered by hydraulic rams, power-operated by the tractor engine. There are two rams, each with a lifting capacity of 15 tons, carried on a heavy subframe, attached immediately forward of the rear axle of the standard 33-in. SAE lower-half fifth wheel. The bottom ends of the ram cylinders are mounted on trunnions and the top ends of the rams are fitted with heavy-duty balls, held in spherical housings. Both the operating lever for the coupling pin and the controls for the rams can be worked from the driver's seat, so that loaded semitrailers can be hitched or unhitched, and raised or lowered, without the driver having to leave the cab. The tractor is intended to be used for yard shunting, hauling loads up to 60 tons at speeds ranging from 1.2 to 15 mph. As it was not designed for open-road haulage, it is not fitted with rear springs, the rear axle being fixed rigidly to the frame to give the maximum stability.

Hydraulically raised trailer coupling gear. Side view of newly designed tractor which hauls loads up to 60 tons at speeds ranging from 1.2 to 15 mph.

Gas-Turbine Power Station at Leghorn

What is claimed to be the largest gas-turbine power station yet constructed is now in service in Leghorn, Italy. It is owned by the Società Elettricità Selt-Valdarno of Florence and contains two gas-turbine generator sets, each of 25-mw capacity, built by Brown, Boveri and Company, Baden, Switzerland. With an air temperature of 17.07 C and cooling water at 19.29 C, the first set to be installed showed an efficiency of 24.315 per cent, with an output of 25,097 kw. When the second set was tested on site, the air temperature was 19.52 C and the cooling water 21.69 C, the output being 24,436 kw and the efficiency 24.102 per cent. The fuel used is heavy oil. No heat exchangers are fitted, as it was found that they offered no advantage in economy. Subsequent running in service has maintained a steady efficiency of about 25 per cent and has shown that the sets have an ample reserve of power.

Walking Dragline Excavator

For the past six years, the claim to possess the world's largest walking dragline excavator has rested with the English steel firm of Stewarts & Lloyds, Ltd., but this claim is now challenged by another English steelmaking combine, the United Steel Companies, Ltd., who have recently put to work in an open-cast ironstone quarry near Stamford, in Lincolnshire, England, a machine of similar design, but which is stated to be slightly heavier. It has been constructed by the Ipswich firm of Ransomes and Rapier, Ltd., who also built the former machine, and has cost the equivalent of $2^1/_4$ million dollars. The jib, of tubular steel, all-welded, is 282 ft long, which permits dumping at a radius of 260 ft and at a height of 120 ft above ground level. The bucket is of 20-cu-yd capacity and is also all-welded, with renewable teeth. It picks up 30 tons of overburden at a bite. At the deepest part of the 3000-acre site, the thickness of the overburden (which is mostly limestone) is from 80 to 90 ft. The digging of the ironstone itself will be done by smaller excavators, which will load it into rail cars for transport 75 miles to the steelworks of the Appleby-Frodingham Steel Company.

The machine is electrically driven, taking power from the mains at 6600 volts a-c through a trailing cable. The current feeds two 1500-hp motor-generator sets which supply direct current to the 14 main motors, each of 225 hp. Ward-Leonard amplidyne control gear is fitted. All the electrical equipment is housed in a large motor room, occupying the greater part of the revolving superstructure and spanned by a 25-ton traveling crane.

[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

The main frame of the superstructure consists of four longitudinal girders, 14 ft deep and 75 ft 9 in. long, connected by transverse bulkheads and cross girders and surmounted by a bridge girder, of the full width of the frame, which takes the load when the machine is "walking." The superstructure is supported on a circular base of structural steel, 48 ft in diam, which carries the roller path and the rack for rotating; it revolves round a steel center post, 2 ft 4 in. diam. The roller path is of bridge rail section, 47 ft in diam, and consists of 32 segmental castings of nickel-chrome-molybdenum steel. It carries a live ring of 120 tapered rollers. The rack for rotation is also constructed of cast-steel segments and has 208 teeth of 6-in. circular pitch, $19^1/_2$ in. deep. Rotation is effected by two gear units, each with its own 225-hp motor, which turn the superstructure at $1^1/_4$ rpm. This corresponds to a jib-head speed of 2000 fpm, or nearly 23 miles an hour. The maximum torque about the center post is rather more than 7 million lb-ft. The complete cycle of digging, slewing, dumping, and returning for the next cut takes about one minute.

The hoist and drag motions are operated by two separate units, each having four 225-hp motors driving through reduction gearing to the winding drums. Each drum is grooved to take two ropes in right-hand and left-hand grooves. The maximum pull on each drum is 100 tons. Rope speeds range from 290 fpm at full load to 513 fpm at no load.

The remaining four 225-hp motors drive the walking gear, which, being mounted on the revolving superstructure, enables the machine to progress in any direction, by steps of 6 ft $10^1/_2$ in. The two walking shoes, one on each side of the superstructure, measure 48 ft long by 9 ft 6 in. wide and are carried on vertical legs, operated by eccentrics. The weight of the machine, 1675 tons, is supported on hollow stub axles which form part of the bridge girder; thus the load is transmitted directly to the superstructure and not through the driving mechanism. The driving shafts pass through the stub axles to the eccentrics and are subjected to torsional stresses only. The eccentrics are fitted with rollers, running in machined paths in the legs; and the connection to the shoes is by ball-and-socket joints, to allow the shoes to accommodate themselves to uneven ground.

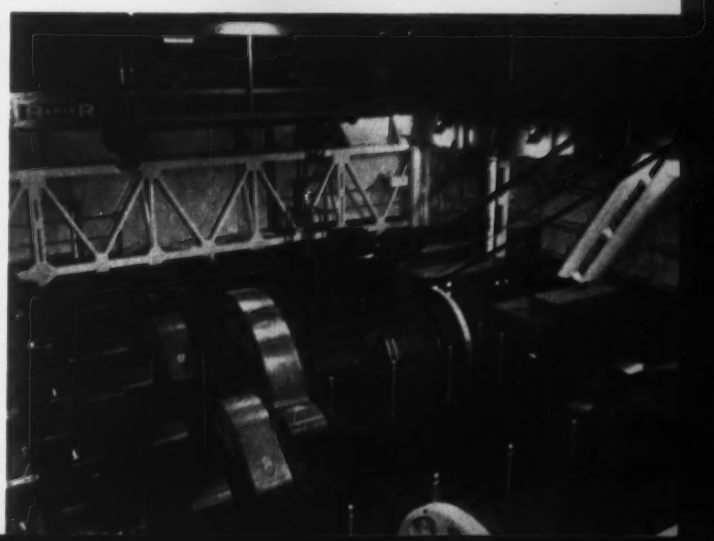
The jib is triangular in section, with two double-tube compression members and one double-tube tension member. A tubular suspension member connects the jib to the head of the A frame, but a hoisting winch is also fitted, with a ten-part rope purchase, to enable the jib to be lowered to the horizontal position. In normal use, the jib is rigidly held by the suspension member and no load is taken by the winch rope. Steel safety links attach the suspension member to the A frame, and alternative links of different lengths can be inserted if desired, to vary the working angle of the jib.

There are two driving cabins, one on each forward corner of the superstructure, so that the driver can operate the machine from either side. The controls are completely duplicated in the two cabins. A slight excess of air pressure over that of the atmosphere is maintained in the whole superstructure house by means of electrically driven fans fitted with air filters, to cool the electrical equipment and to prevent the entry of dust. Access to the house is through airlocks, in which are warning lights to guard against both doors being opened at the same time.

General view of walking dragline with load of overburden in the bucket. Jib, 282 ft long, permits dumping at radius of 260 ft and height 120 ft above ground level.

Walking dragline showing view of one of the driving cabins located on the forward corner of the superstructure. Walking shoe is lowered to the ground prior to taking a stride.

Motor room of walking dragline showing four 225-hp motors geared to the hoist rope winding barrel; a similar group of motors drive the drag rope barrel. Note 25-ton overhead crane.



ASME Technical Digest

Substance in Brief of Papers Presented at ASME Meetings

Process Industries

Standardization of Centrifugal Chemical Pumps, by C. J. B. Mitchell, Mem. ASME, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del. 1957 ASME Semi-Annual Meeting paper No. 57—SA-77 (multilithographed; available to April 1, 1958).

STANDARDS for centrifugal pumps for chemical-industry use are currently being formulated by American Standards Association Sectional Committee B73. The committee was formed in 1953 after a conference of the Manufacturing Chemists' Association and the Chemical Industry Advisory Board of the American Standards Association. Producers, users, and general interest groups make up this committee. The producers are represented by five members of the Hydraulic Institute, and four nonaffiliated members. Representatives from such organizations as the Manufacturing Chemists' Association, The Society of the Plastics Industry, Inc., The Chlorine Institute, and others, represent the producers. The general interest group is composed of representatives from The American Society of Mechanical Engineers, American Institute of Chemical Engineers, American Chemical Society, and others.

A definition of the problems encountered with centrifugal chemical pumps revealed several general areas which would benefit from standardization.

Dimensional variation between pumps of like capacity is of the greatest consequence to the user designing and constructing a new plant or project. If all manufacturers' pumps had equal boundary dimensions, foundation and piping drawings could be issued without delay. Expenditures of time and money would be reduced. Uniform external dimensions among all manufacturers' products would permit interchangeability among pumps of different manufacturers in existing plants.

The variation in shaft and packing-box dimensions also results in excessive costs. With the increased use of mechanical seals, a minimum number of shaft sizes, and uniformity of shaft and packing-box dimensions among manufacturers becomes an economic necessity.

Lack of standardization of centrifugal chemical pumps presents problems of maintenance. While uniformity is desirable, it is necessary that there be a certain degree of design freedom in order that improvements might be made. Such considerations made it inadvisable to attempt to standardize wetted parts.

The committee also considered an area of improvement involving the addition of special features on pumps for chemical-industry use. Certain aspects of chemical plant environment demand materials, methods, fittings, and other features of a special nature.

Savings of approximately $6 million are estimated if uniformity is achieved in the above categories.

Studies made by the committee defined its aims:

1 To establish, within bounds which would not restrict creative design and originality, standard external sizes and shaft and packing-box dimensions.

2 To develop standards of features to be included in all chemical pumps—standards which would be beneficial to users, and practical for manufacturers.

The committee has taken a survey of 25,328 pumps. Of these, 50 per cent were purchased for capacities of 50 gpm or less, and 47 per cent of the pumps purchased were of some type of stainless steel.

Tentatively, pump sizes have been determined; shaft sizes have been selected from an American Standard preferred number series; packing-box dimensions are based upon shaft size; and boundary dimensions have been established.

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Designing Process Plants in Relation to Maintenance, by H. J. Monnik, Catalytic Construction Company, Philadelphia, Pa. 1957 ASME Semi-Annual Meeting paper No. 57—SA-66 (multilithographed; available to April 1, 1958).

MAINTENANCE problems are inherent in every industry. This paper discusses the maintenance problems which are peculiar to the process industries of which petroleum refineries and chemical plants are typical.

The primary functions of maintenance groups are to effect repairs as rapidly as possible in order to minimize downtime, and to devise ways and means of prolonging the operating cycle. It is suggested that the design of process plants with consideration for these maintenance functions would hold down maintenance costs.

Maintenance plans should begin with plant layout. If a pattern is established in the placement of major facilities, process materials will flow smoothly, will be accessible, and traffic flow in the plant will be smooth. If the pattern also includes water and sewer lines and electrical conduits, maintenance needs will be minimized.

Further consideration should be given to the placement of maintenance shops. Once the number and kinds of shops necessary (machine shop, welding shop, and so on) have been determined, effort should be made to locate the shops centrally.

Ease of operation and ease of maintenance are the chief concerns in the arrangement of each individual unit within the plant. Scale models often make it possible to determine the need for rearrangement of piping, additional platforms, and the method of removing equipment on which maintenance must be performed.

In ordering equipment there are often instances where package units may be purchased. Careful scrutinization of such equipment can easily reduce operating difficulties and continuing maintenance problems.

Standardization and the subsequent reduction of the variety of stock required can also serve to minimize maintenance costs.

As a further precaution for the reduction of maintenance needs, it is suggested that designers be thoroughly familiar with codes and adhere strictly to them.

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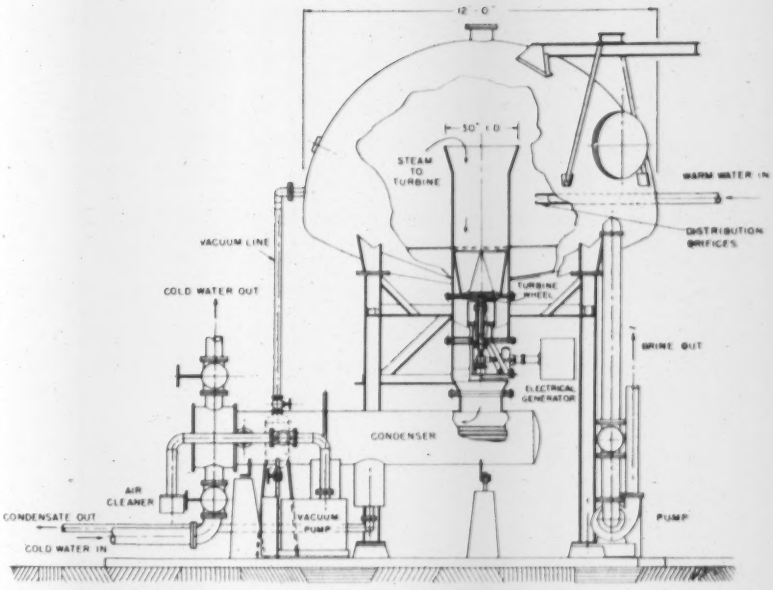
Vacuum Flash Distillation of Sea Water, by E. D. Howe, Mem. ASME, University of California, Berkeley, Calif. 1957 ASME Semi-Annual Meeting paper No. 57—SA-92 (multilithographed; available to April 1, 1958).

CONVERSION of sea water to fresh water has required large amounts of fuel. The possibility of using sources of energy such as waste heat or solar heat are explored in this paper. The use of solar heat for water purification can be applied

in several ways: (*a*) By direct heating of water in hood-type solar heat collectors, with condensation in the same device; (*b*) by condensation of vapor from humid sea breezes; (*c*) by the use of solar heat collected by the water in the ocean or in large ponds, used as a source of energy for vacuum flash distillation and power generation.

The present status of the vacuum flash distillation system using low temperature differences is discussed at length as a means of producing distilled water. This system is based on the ideas advanced by Claude for generating mechanical power from heat in the ocean. Warm water from the surface of the ocean was to be passed into a vacuum flash evaporator and the steam produced thereby was to be passed through a turbine wheel to generate power and then condensed by use of the cold water drawn from deep in the ocean. In tests conducted at the University of California, the source of temperature differential was assumed to be that between the temperature of waste warm water from oil refineries or chemical plants, versus the surface water temperature of the ocean.



Low temperature difference plant for vacuum flash distillation of sea water

The objectives of the experimental program were twofold, namely, (*a*) to evolve an evaporator suitable for operation at saturation temperatures of 95F and less and to determine the performance characteristics of this unit; (*b*) to set up a complete plant of this general type in order to clearly define the several design problems which should be solved.

Heat Transfer

Fast-Response Thermocouples Using Tubular Hot-Junction Elements, by A. H. Murphy, Armour Research Department of Illinois Institute of Technology, Chicago, Ill., and G. Stevens, Crucible Steel Company, Pittsburgh, Pa. 1957 ASME Semi-Annual Meeting paper No. 57—SA-1 (multilithographed; available to April 1, 1958).

MODERN-AIRCRAFT gas turbines require sensing elements which are capable of following fluctuations in exhaust-gas temperature with a minimum time lag. Sensors used to actuate control systems as well as instruments used for over-temperature protection are subject to these requirements.

This paper presents a systematic study of designs for thermocouples to be used as aircraft-temperature detectors. In order to produce a usable sensor it was necessary to compromise between rate of response, mechanical strength, resistance to vibration, and space limitations.

A conventional thermocouple hot junction consists of two dissimilar wires twisted together, which are welded at their free ends to form a bead. The rate of response of this thermocouple is largely dependent upon the mass of the hot-junction weld. From purely geometric considerations it was deduced that a thin-wall tubular junction would achieve a large ratio of surface area to mass; this in turn would produce rapid response of the thermocouple. The technical difficulties connected with the alignment and butt welding of thin-wall tubing, however, stood in the way of an early realization of this objective.

Furthermore, in order to be acceptable in jet engines, other requirements of sensor design had to be met:

1 Good resistance to static mechanical loading.

2 No resonance of natural vibration frequencies at the critical vibrational excitations of the engine.

3 Restriction of dimensions to the allocated space.

4 Amenable to the use of conventional fabrication methods.

From the present study there evolved three basic designs which incorporated a welded tubular hot junction: Loop-type, stirrup-type, and pencil-type thermocouples.

The construction of a loop-type thermocouple was obtained by modifying existing jet-engine thermocouples. A circumferential weld joins short lengths of chromel and alumel tubing. This circular "hot junction" is located midway between the toed-in solid thermocouple wires; in turn these are slipped into the tube ends with the corresponding alloy composition (chromel to chromel, alumel to alumel). The final step consists of welding the tubular element to the thermocouple wires.

The design of stirrup-type thermocouples makes use of heavy wires to increase the structural rigidity of the unsupported thermocouple end. These supports are flattened and drilled to receive the matching ends of the tubular element. Again the tube is arc-welded to the solid wires.

The pencil-type was not thoroughly investigated. The essential components are the bimetallic tubular element welded at one end to a heavy-wall chromel casing. The other end of the tube is pointed to receive an alumel return wire. The anticipated advantages of this design are compactness, rigidity, vibration resistance, and ease of manufacture. It should be realized, however, that the chromel tube casing forms part of the thermocouple circuit and, therefore, must be electrically insulated at the point of mounting.

Experimental data are presented which relate characteristic response time of the thermocouple to the dimensional varia-

bles of a tubular hot-junction element: Tube diameter, wall thickness, and distance between supports.

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Laminar Mass and Heat Transfer From Ellipsoidal Surfaces of Fineness Ratio 4 in Axisymmetrical Flow, by Shao-Yen Ko, Assoc. Mem. ASME, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., and H. H. Sogin, Assoc. Mem. ASME, Brown University, Providence, R. I. 1957 ASME Semi-Annual Meeting paper No. 57—SA-44 (multilithographed; to be published in Trans. ASME; available to April 1, 1958).

Calculation of the heat transfer on blunt surfaces of revolution is encountered in the design of anti-icing equipment for some types of aircraft. When total rates of heat transfer are needed the mean coefficient of heat transfer from an isothermal surface may provide a satisfactory estimate. The purpose of this investigation was to provide such data.

The calibration of the heat-mass analog given by Sogin is employed to obtain mean coefficients of heat transfer from the nosepieces of ellipsoid-cylinders to air in axisymmetrical flow. The results for the ellipsoidal surface of axis ratio 4:1 are represented by the equation

$$\left(\frac{h}{Gc_p} N_{Pr,f}^{2/3}\right) \cdot \sqrt{\frac{GS}{\mu_f}} = 0.76$$

in the range of Reynolds number from 32,500 to 280,000. They are compared with the results of a wedge-flow approximation of the boundary-layer solution and with results from other investigations on related shapes.

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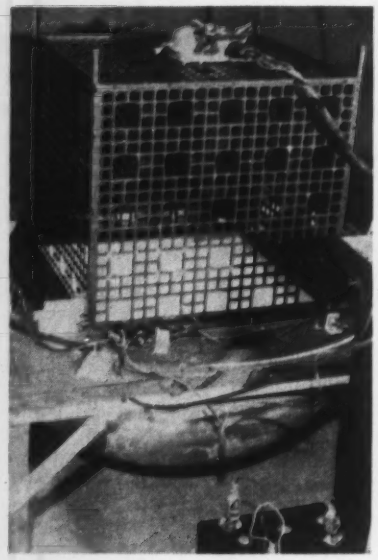
A Model Method for Determining Geometric Factors in Solid-to-Solid Radiation Heat Transfer, by P. L. Tea, Washington State College, Pullman, Wash., and H. D. Baker, Mem. ASME, Columbia University, New York, N. Y. 1957 ASME Semi-Annual Meeting paper No. 57—SA-10 (multilithographed; to be published in Trans. ASME; available to April 1, 1958).

In theory, a complete analysis of a heat-transfer problem by the mechanism of solid-to-solid radiation through a nonabsorbing medium presupposes a knowledge of all surface temperatures, emissivities of surfaces, degrees of diffuseness of all emitted energy, the natures of all reflections (diffuse, specular, or in between) of all emitting and receiving surfaces, and their geometrical relationships. Several ingenious methods of attack are available for determining the geometric factors needed in the Stefan-Boltzmann equation.



Over-all view of model with cubical for determining geometric factors in solid-to-solid radiation heat transfer

Most methods postulate perfectly diffuse emission and reflection of radiation—that is, of the same angular distribution as blackbody radiation. Admittedly, not all problems fall within this realm. The model technique used in this paper attempts to approach conditions where reflections are other than perfectly diffuse.

Basically, the model comprises a visible-light source, a detector unit, and receiving surfaces, all of unique design. The aims are fourfold: (*a*) A working tool of moderate cost, with which a diversity of configurations may be set up and tested quickly and accurately; (*b*) simulation of a uniform, perfectly diffuse plane source of radiation of any shape; (*c*) a detector unit which is linear in its response, virtually immune to fatigue, and which is equally sensitive to radiation arriving at any angle of incidence, that is, negligible cosine error; and (*d*) receiving surfaces which can, when desired, simulate perfectly diffuse reflection or reradiation, regardless of the angular distribution of the incident flux.

The objectives of the tests were to check the uniformity of the source, and to check calculated results for two model chambers. In one chamber, receivers were perfectly absorbing, and in the other, interreflections occurred.

Excellent agreement between experimental results and theory for the cube and the cylinder, together with the good uniformity of the source, indicate that this model technique may be used with confidence for other, more difficult configurations.

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Dynamic Response of Heat Exchangers Having Internal Heat Sources—Part I, by J. A. Clark, University of Michigan, Ann Arbor, Mich.; V. S. Arpaci, Massachusetts Institute of Technology, Cambridge, Mass.; and K. M. Treadwell, Westinghouse Atomic Power Division, Pittsburgh, Pa. 1957 ASME Semi-Annual Meeting paper No. 57—SA-14 (in type; to be published in Trans. ASME; available to April 1, 1958).

Dynamic response of the bulk temperature of the coolant in a heat exchanger having time-variant heat sources is evaluated analytically as a function of space and time. The mathematical development involves the use of the Laplace-transform technique. Results of the theory are compared with experiment and favorable agreement is obtained. Both theoretical and experimental results are included. Heat exchangers to which the solutions apply include the heterogeneous nuclear reactor.

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Measurements of the Total Absorptivity for Solar Radiation of Several Engineering Materials, by R. C. Birkebak and J. P. Hartnett, Assoc. Mem. ASME, University of Minnesota, Minneapolis, Minn. 1957 ASME Semi-Annual Meeting paper No. 57—SA-27 (in type; to be published in Trans. ASME; available to April 1, 1958).

Values are presented of the total solar absorptivity of several porous materials presently being considered for transpiration cooling of high-speed vehicles. To specify these surfaces photomicrographs and a chemical analysis are presented. Two schemes used in the measurement of the absorptivity values are described in the text, a comparison technique and an integrating radiometer method.

•

Heat Transfer Between a Flat Plate and a Fluid Containing Heat Sources, by I. R. Whiteman, University of California, Los Angeles, Calif. 1957 ASME Semi-Annual Meeting paper No. 57—SA-4 (in type; to be published in Trans. ASME; available to April 1, 1958).

The Leveque solution for the case of a fluid flowing past a flat plate has been expanded to include the presence of heat sources in the fluid. Through the use of certain approximations, an expression has been obtained for the heat flux through the plate for given plate temperature and source, and an expression for the plate temperature for given heat flux and source.

Similar Solutions for Free Convection From a Nonisothermal Vertical Plate, by E. M. Sparrow, Assoc. Mem. ASME, and J. L. Gregg, Lewis Flight Propulsion Laboratory, Cleveland, Ohio. 1957 ASME Semi-Annual Meeting paper No. 57—SA-3 (in type; to be published in Trans. ASME; available to April 1, 1958).

An analysis is made for laminar free convection from a vertical flat plate having a nonuniform surface temperature. The following two families of surface temperatures were studied: (*a*) $T_w - T_\infty = Nx^n$, (*b*) $T_w - T_\infty = Me^{mx}$. Both families submit to mathematical analysis by the conventional techniques of laminar boundary-layer theory; i.e., they permit the finding of similar solutions of the boundary-layer equations. Numerical solutions have been carried out for Pr = 0.7 and 1.0; i.e., for gases. Heat-transfer results are presented, as are temperature and velocity distributions.

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On the Stagnation of Natural-Convection Flows in Closed-End Tubes, by S. Ostrach and P. R. Thornton, Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1957 ASME Semi-Annual Meeting Paper No. 57—SA-2 (in type; to be published in Trans. ASME; available to April 1, 1958).

An analysis of the laminar natural-convection flow and heat transfer in a closed-end tube with a linear wall temperature and large but finite length-radius ratio is presented. It is found that, for a given relation between the two physical parameters of the problem, the flow will fill the entire tube length. Representative velocity and temperature profiles are presented to show the effects of the parameters on the flow and heat transfer.

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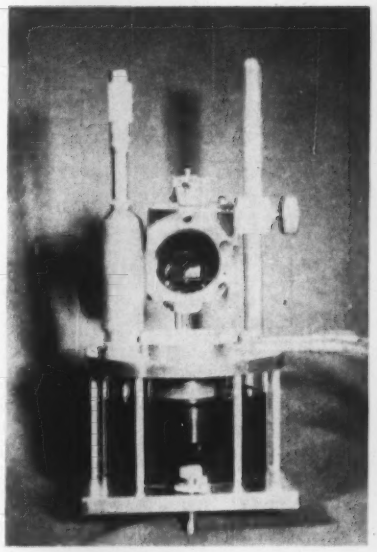
Description of a New Sensitive Micromanometer, by R. Eichhorn, and T. F. Irvine, Jr., University of Minnesota, Minneapolis, Minn. 1957 ASME Semi-Annual Meeting paper No. 57—SA-63 (multilithographed; available to April 1, 1958).

For local pressure measurements in a flow field at low Reynolds numbers a very sensitive micromanometer is required. In general, a low Reynolds number can be obtained by making the characteristic length dimension small or by operating with low velocities. The first possibility is limited by the fact that the pressure-probe diameter must be decreased in proportion to the dimension characteristic to the flow field in order to assure truly local measurements. Eventually, this decrease also produces inconveniently low response times. Decreasing the velocities is therefore the most desirable way to obtain small Reynolds numbers when a micromanometer of sufficient accuracy is available.



New sensitive micromanometer for local pressure measurements in a flow field at low Reynolds numbers

This paper describes a modified type of U-tube manometer. Essentially, the instrument consists of two concentric cylinders capped at the top and connected at the bottom by manometer fluid.

A hollow metal cylinder which floats in the inner chamber is hinged so as to rotate with changes in the liquid level. A mirror, cemented to the top of the float allows an optical observation by means of a telescope and scale of these level changes. A cylindrical displacement rod in the outer chamber is used for calibration.

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The Biotechnical Problem of the Human Body as a Heat Exchanger, by L. P. Herrington, The John Pierce Foundation, New Haven, Conn. 1957 ASME Semi-Annual Meeting paper No. 57—SA-5 (in type; to be published in Trans. ASME; available to April 1, 1958).

The physical and engineering properties of inanimate objects as heat exchangers have been the subject of long study. Within the past 25 years, many factors have brought biological disciplines into intimate contact with the formally similar problem of heat exchange between a living body and its environment. A Committee on Biotechnology of the Heat Transfer Division of this Society has been organized recently with the intention of advancing and standardizing useful engineering descriptions of biological heat-exchange problems. Such problems presently complicate engineering design in which the human link is a critical element in total function of man and machine. The paper demonstrates that a large body of calorimetric data on the human heat exchanger can be summarized in statistically derived empirical equations. These equations obviate the need for special physiological knowledge required of the engineer who would make such computations from the classical equations of heat loss.

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Transient Free Convection From a Vertical Flat Plate, by Robert Siegel, Assoc. Mem. ASME, Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1957 ASME Semi-Annual Meeting paper No. 57—SA-8 (in type; to be published in Trans. ASME; available to April 1, 1958).

The method of characteristics is employed to obtain solutions to the time dependent free-convection equations of momentum and energy placed in integral form (Karman-Pohlhausen method). Two boundary conditions are considered for a vertical flat plate of infinite width and semi-infinite length which is initially at ambient temperature in quiescent fluid: (*a*) The plate is suddenly raised to a uniform higher temperature; and (*b*) the plate suddenly begins to produce a uniform heat flux at its surface. The results yield the time required for steady flow to be established as a function of position along the plate. Heat-transfer coefficients are obtained for the initial stage of motion during which the convective process is one dimensional. The approximate velocity and temperature profiles obtained from the analysis are compared with more precise solutions of the differential equations for the initial stage of motion and for steady state.

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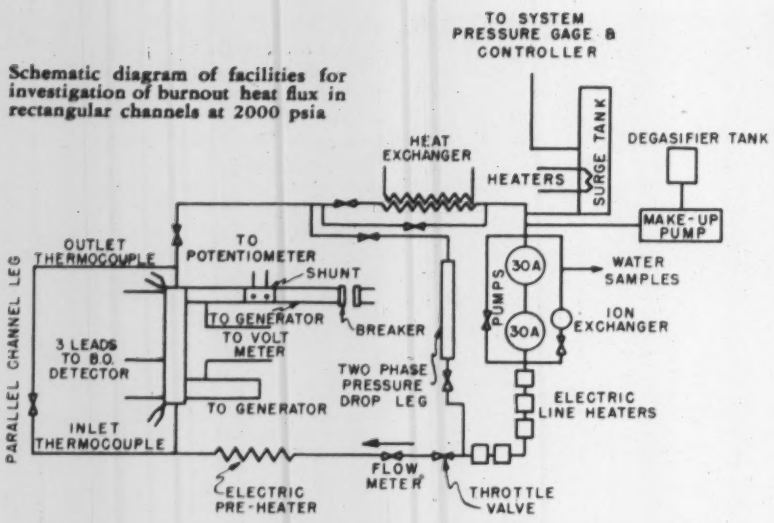
Investigation of Burnout Heat Flux in Rectangular Channels at 2000 Psia, by H. S. Jacket, Assoc. Mem. ASME; J. D. Roarty, Assoc. Mem. ASME; and J. E. Zerbe, Assoc. Mem. ASME; Westinghouse Electric Corporation, Pittsburgh, Pa. 1957 ASME Semi-Annual Meeting paper No. 57—SA-6 (in type; to be published in Trans. ASME; available to April 1, 1958).

Burnout heat-flux data were obtained under conditions of approximately zero exit quality and bulk boiling at the exit of electrically heated test specimens. These specimens were long, narrow channels with various slot thicknesses, surfaces, materials, and length-to-diameter ratios. Tests were run at 2000 psia and mass velocities from approxi-



Schematic diagram of facilities for investigation of burnout heat flux in rectangular channels at 2000 psia

mately 0.2×10^6 to 3×10^6 lb/hr-sq ft. The effect of inclining the channel at 45 deg also was investigated. The rectangular channel burnout results are in reasonable agreement with data previously obtained for round tubes. A design equation is suggested which yields a conservative estimate of the burnout heat flux in the low subcooling and quality regions for the range of variables investigated herein. A burnout loop and method of operation are described.

Performance Factors of a Periodic-Flow Heat Exchanger, by T. J. Lambertson, Student Mem. ASME, U. S. Naval Postgraduate School, Monterey, Calif. 1957 ASME Semi-Annual Meeting paper No. 57—SA-13 (in type; to be published in Trans. ASME; available to April 1, 1958).

A NUMERICAL finite-difference method of calculating the effectiveness of the periodic-flow type heat exchanger is presented by considering the metal "stream" in crossflow with each of the gas streams as two separate but dependent exchangers. A general purpose digital computer was used to accommodate the large number of subdivisions necessary for accuracy and an extrapolation of data to zero element area such that the values of effectiveness are good to four significant figures. The exchanger effectiveness has been evaluated over the following range of dimensionless parameters

$$1.0 \geq C_{min}/C_{max} \geq 0.10$$

$$1.0 \leq C_r/C_{min} \leq \infty$$

$$1.0 \leq NTU_o \leq 10$$

$$1.0 \geq (hA)' \geq 0.25$$

Wood Industries

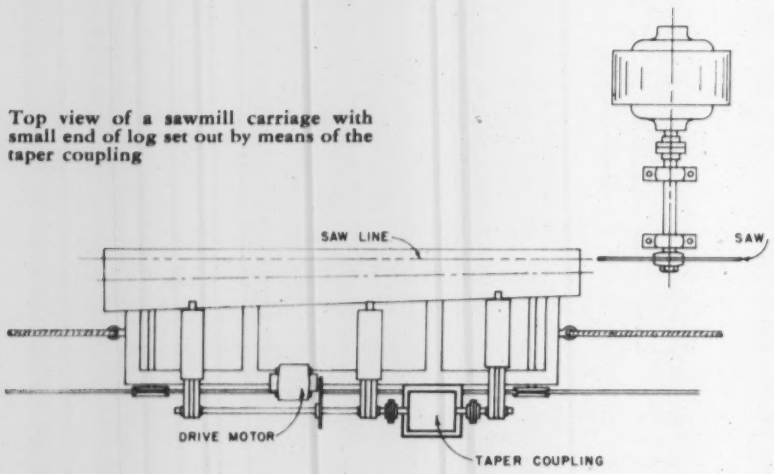
A Mechanical Unit for Taper Sawing, by M. H. Mater, Mem. ASME, and J. M. Matuszak, Assoc. Mem. ASME, Mater Machine Works, Inc., Corvallis, Ore. 1957 ASME Semi-Annual Meeting paper No. 57—SA-83 (multilithographed; available to April 1, 1958).

AS THE cost of logs increases and good quality logs become less plentiful, a need develops for a method to obtain higher grade lumber from tapered and crooked saw logs. As operating expenses increase the need for taper sawing also increases. Production time, however, must not be sacrificed in order to up-grade the lumber produced from inferior grade logs.

In order to obtain the best quality of lumber from any log, and particularly from logs with bad centers, jacket or outer boards are removed from the periphery of each log. In the case of logs of more or less uniform diameter, the jacket boards can be removed simply by rotating the log to each face for cutting. Where jacket boards are to be removed from tapered logs, a method must be found to set out the small end of the log. Thus any wedge-shaped pieces will then be removed from the residual heart wood where quality is already low.

Several devices are currently being used to facilitate taper sawing. The tapering blocks, the tapering plate, and a special-power tapering knee are among the methods described in this paper. Each has inherent disadvantages. One type requires time for setting up which slows production. Each provides only a certain amount of taper setting which limits the sawyer's efforts to obtain top-grade lumber. These methods are described in order to provide a background for discussing the development of a new mechanical tapering device. This new unit provides a rapid means of setting a variable amount of taper and automatically removes the taper for nontaper sawing.

A complete description has been presented of the development and operation of the taper coupling. The standard knee moved by using the taper coupling provides tapering forward or back to any desired amount with the use of existing power. By remote control the sawyer can establish the taper for the next log while the carriage is returning after dropping the backstand. Thus lumber



Top view of a sawmill carriage with small end of log set out by means of the taper coupling

from tapered logs can be more accurately up-graded and at the same time production can be increased.

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Remote-Control Systems for Setting Sawmill Carriages, by L. R. Gensman, Mem. ASME, Monarch Forge and Machine Works, Portland, Ore. 1957 ASME Semi-Annual Meeting paper No. **57—SA-78** (multilithographed; available to April 1, 1958).

THE sawmill carriage is the unit of sawmill machinery which transports the log past the headrig, enabling the saw to remove boards or "cants" from the log. This is the first step involved in the breakdown of the log in a sawmill, and the speed, accuracy, and efficiency of this operation will set the pace for the entire sawmill. Therefore, the carriage is of primary importance in the industry.

The evolution of remote-control carriage-setworks systems has progressed from hand setting-hand dogging, through power setting-and-dogging to modern carriages with one rider who, under the direction of the sawyer, sets and dogs the logs. More than 300 remote setworks systems have been installed in sawmills in the past four years, mostly in the Pacific Northwest. Starting with stud mills requiring about 5000 sets per day or more than 10 sets per min, they have been refined and improved to where, in even the most diversified sawmill, there is potential advantage in their use.

Almost all of the disadvantages of the remote setting systems are technological, it is probable that most of these will be overcome within the near future. Equipment similar to that described in this paper undoubtedly will be applied to resaws and edgers, as well as to any other saw-mill machinery requiring accurate positioning. Indeed, one manufacturer is presently producing a line-bar resaw so equipped. There is nothing in the requirements of remote setworks that would preclude the application of types of servomechanisms, other than those described herein, to sawmill machinery. It is to be expected that much greater development in this direction will be made. Indeed, it appears presently that the only limiting factor is an apparent fixation on the part of some sawmill operators; a feeling that the only satisfactory method of making lumber is the one used by grandfather. It may take a new generation of operators to overcome this, but inexorably the sawmill operators who do not embrace modern technology will be forced out by those who do.

Wood Equivalents—Logs to Boards, Plywoods, and Products From Residuals, by S. M. Batori, Mem. ASME, Controls and Communications Company, Eugene, Oreg. 1957 ASME Semi-Annual Meeting paper No. **57—SA-88** (multilithographed; available to April 1, 1958).

BOARDS, plywoods, chips for pulping, briquets, and fireplace logs are some of the many products of a simple log. Recent trends toward more complete utilization of the wood removed from the forests has prompted planners and engineers concerned with economic planning and mill design to investigate the end result of every pound of the log that comes from the forest.

Knowledge derived from such investigation governs the addition of a new mill, and new process; and the engineering design of a new conveyer, the size of a chipper; or the presence or absence of a new power plant in the mill.

Studies have been made to determine what becomes of the log after it reaches the sawmill or plywood mill, but wood is such a variable product that studies do not agree.

In this paper an attempt is made to provide the engineer with a set of equivalents which will aid in design and planning. The tables and equivalents presented refer to current practices in the fir regions of British Columbia, Washington, Oregon, and California. Much of the data is applicable also to hemlock, spruce, red cedar, and pine.

Applied Mechanics

The Forced Lateral Oscillations of Trailers, by A. Slibar, Technical University of Vienna, Vienna, Austria, and P. R. Paslay, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1957 ASME Applied Mechanics Summer Conference paper No. **57—APM-4** (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

AT PRESENT there is no satisfactory theory explaining the mechanical behavior of a system consisting of a pulling vehicle and a trailer. This is partially due to the complexity of the problem and the lack of knowledge about the forces transmitted from the road to the wheel.

A trailer and a towing vehicle possess many degrees of freedom, and a large number of parameters influence the response of the system. These circumstances make it necessary to idealize the given system to a simpler one accessible to analytical treatment.

The resulting motion depends on both the towing vehicle and the trailer. If snaking of the trailer occurs, both elements of the system take part in the motion. Only when the towing vehicle is many times heavier than the trailer may the motion of the pulling vehicle produced by the trailer be neglected. Even in the case of a heavy towing vehicle, corrections in the steering make the assumption of the towing vehicle running on a straight line unsatisfactory. The assumption of a straight-line motion of the tow point does not yield the forced lateral response of the trailer. For this analysis the forward component of the tow-point velocity is assumed to be constant while the lateral component varies sinusoidally with time.

Since the road is assumed to be smooth and level the influence of the springs of the trailer as well as of the towing vehicle is neglected.

This paper gives the mechanical response of a simplified model of a trailer when its tow point moves along a certain prescribed path. The type of path considered here is described by a constant forward velocity in which is superimposed a low-velocity-amplitude, sidewise, periodic motion. In this investigation analytical expressions proposed by Huber were used for the forces and moments on the tires. The equations of motion are studied for small slip angles. The analysis leads to a prediction of the natural frequency of the trailer and shows that the damping of the system due to slip of the tires is inversely proportional to the forward velocity of the trailer.

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An Elongating String Under the Action of a Transverse Force, by W. Goldsmith, Assoc. Mem. ASME, University of California, Berkeley, Calif. 1957 ASME Applied Mechanics Summer Conference paper No. **57—APM-9** (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

ROCKETS are used in a number of applications involving the unreeling of a long flexible cord or wire from a relatively fixed source. The end of the cord which is attached to the rocket experiences transverse oscillatory displacements in accordance with the more or less regular yawing and pitching motions of the rocket.

It is of interest to discover whether or not the coupled motions of the rocket and the cord are capable of producing resonances which will result in the generation of transverse waves of large amplitude in the cord. The occurrence of large

amplitude waves in the cord probably would result in a modification of the trajectory of the rocket in such a way as to deflect it from the desired course. An analysis of this problem is the object of this paper.

The motion of a uniform undamped flexible string whose length increases with time has been investigated when an arbitrary time-dependent force acts transversely at the free end. The method of characteristics has been employed to derive analytical expressions for the transverse displacement in the subsonic regime. Cases are considered when the free end of the wire moves either at constant velocity or at constant acceleration. Numerical solutions are presented in dimensionless form for a sinusoidal forcing function of arbitrary amplitude and fixed frequency. The possibility of the existence of resonances in the string has been examined.

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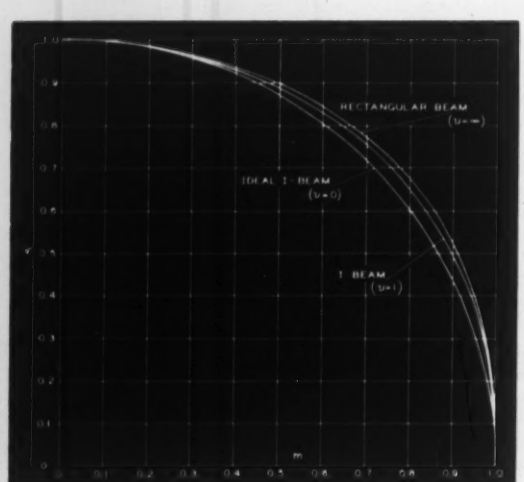
Interaction Curves for Shear and Bending of Plastic Beams, by P. G. Hodge, Jr., Mem. ASME, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1957 ASME Applied Mechanics Summer Conference paper No. **57—APM-19** (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

In a recent paper Drucker has shown that there cannot be a true interaction curve between bending moment and shear force in a plastic beam, since the relation depends upon the entire span of the beam. He arrived at his results by considering plane-stress fields within the beam and by using the upper and lower-bound theorems of limit analysis. While such an approach is more accurate than a directly formulated beam theory, it also leads to more difficult problems to solve. On the other hand, the simple bending theory of plastic beams takes no account of shear, and hence has an unknown amount of inaccuracy when applied to short-beam spans.

In this paper a compromise between the two approaches considers both bending moment and shear as generalized stress variables. The stress problem is then fully defined in terms of the resultant bending moment M and resultant shear V. According to Prager, the corresponding strain variables must be proportional to the curvature rate κ and the resultant shear-strain rate γ of the section. All of these quantities are defined at each section so that it is possible to obtain a unique interaction curve between M and V and a flow rule relating κ and γ. To be sure, it may not be possible to associate stress and strain-rate fields with these quantities which will satisfy the plane-stress equilibrium and compatibility equations. However, the resulting theory will certainly be an improvement on the simple bending theory which completely neglects shear.

Two sections are concerned with the derivation of the interaction curve. This is first approached from the viewpoint of statically admissible stress fields. The maximum safe domain is obtained by use of the variational calculus. Next, it is shown that the same interaction curve can be obtained by starting with a kinematically admissible strain-rate field. The results are presented as integrals for arbitrary cross sections and are evaluated explicitly for rectangular and I-sections.

Some elementary examples are considered in order to compare the predictions of the present theory with simple beam theory and with plane-stress analysis. The final section summarizes the conclusions of the paper.



Shear-moment interaction curve. Curves for values of $0 < \nu < \infty$ must lie between these two; hence the interaction curve differs little between rectangular and I-sections. As an example, the case $\nu = 1$ is shown.

Finite Twisting and Bending of Thin Rectangular Elastic Plates, by Eric Reissner, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1957 ASME Applied Mechanics Summer Conference paper No. **57—APM-23** (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

An exact solution is obtained of the nonlinear equations for finite deflections of thin elastic plates, for a rectangular plate acted upon by twisting moments T and bending moments M simultaneously applied to two opposite edges of the plate. The principal results of the paper are relations between the moments T and M on the one hand, and the angle of twist per unit of length θ, and the curvature k of the plate, on the other hand. These relations which are of the form $T = T(\theta, k)$ and $M = M(\theta, k)$ generalize previously known relations for the special cases for which either $k = 0$ or $\theta = 0$. A numerical evaluation of the functions $T(\theta, k)$ and $M(\theta, k)$ reveals the existence of a characteristic jump phenomenon.

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Saint Venant's Principle: A Biharmonic Eigenvalue Problem, by G. Horvay, Mem. ASME, General Electric Research Laboratory, Schenectady, N. Y. 1957 ASME Applied Mechanics Summer Conference paper No. **57—APM-21** (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

Saint Vinant's principle is formulated as a biharmonic eigenvalue problem for the symmetrical truncated wedge $x \geq 0$, $|y| \leq y_k$ ($y_k = 1 + x \tan \omega$) which is stress-free along the lateral edges, and is loaded by self-equilibrating shear and normal tractions $\tau_k^\circ(y)$, $\sigma_k^\circ(y)$ along edge $x = 0$. It is found that for the wedge angle $2\omega = 0$ the law of decay is of the type $e^{-\alpha_k x}$, for $2\omega \neq 0$ the law of decay is of type $r^{-\mu_k}$; μ_k is minimum for $2\omega = \pi$. The indexes k attached to τ°, σ° indicate that we deal with systems of characteristic tractions which produce characteristic decay rates. Practical implications of the results, as they apply to structural design, are discussed in a separate paper, "Some Aspects of Saint Venant's Principle."

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Displacements in a Wide Curved Bar Subjected to Pure Elastic-Plastic Bending, by B. W. Shaffer, Mem. ASME, and R. N. House, Jr., Assoc. Mem. ASME, New York University, New York, N. Y. 1957 ASME Applied Mechanics Summer Conference paper No. **57—APM-24** (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

Equations have been obtained for the displacements and strains within a wide

curved bar made of a perfectly plastic, incompressible material subjected to a pure bending moment which is sufficiently large to cause elastic-plastic stresses. It is found that whenever the applied load is within 95 per cent of the fully plastic bending moment, displacements and strains in the elastic-plastic problem are of the order of magnitude of the corresponding elastic case. It is also found that when the bending moment reaches approximately 65 per cent of the fully plastic bending moment, the change in material thickness reaches a maximum. It decreases to zero when the bar becomes completely plastic.

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Stress Concentrations in a Strip Under Tension and Containing Two Pairs of Semicircular Notches Placed on the Edges Symmetrically, by A. Atsumi, Tohoku University, Sendai, Japan. 1957 ASME Applied Mechanics Summer Conference paper No. **57—APM-41** (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

Distributions of stresses in an infinite strip of finite breadth under tension and containing two pairs of equal semicircular notches placed symmetrically on the edges are studied theoretically. The state of decreasing of stress concentration is studied and compared with those corrected by M. Isida or newly determined by the author in his calculations as the reliable results of Ling's problem of an infinite strip of finite breadth under tension and containing two semicircular notches placed symmetrically on the edges.

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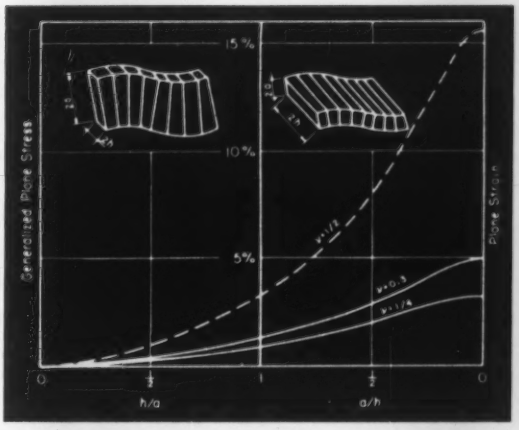
Axisymmetric Thermal Stresses in a Spherical Shell of Arbitrary Thickness, by E. L. McDowell, Assoc. Mem. ASME, Armour Research Foundation, and E. Sternberg, Assoc. Mem. ASME, Illinois Institute of Technology, Chicago, Ill. 1957 ASME Applied Mechanics Summer Conference paper No. **57—APM-14** (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

This paper contains an explicit series solution, exact within the classical theory of elasticity, for the steady-state thermal stresses and displacements induced in a spherical shell by an arbitrary axisymmetric distribution of surface temperatures. The corresponding solutions for a solid sphere and for a spherical cavity in an infinite medium are obtained as limiting cases. The convergence of the series solutions obtained is discussed. Numerical results are presented appropriate to a solid sphere if two hemispherical caps of its boundary are maintained at distinct uniform temperatures.



Magnitude of the phase velocity of long flexural waves, expressed as the percent excess over the velocity for generalized plane stress

Influence of Width on Velocities of Long Waves in Plates, by D. C. Gazis, Assoc. Mem. ASME, and R. D. Mindlin, Mem. ASME, Columbia University, New York, N. Y. 1957 ASME Applied Mechanics Summer Conference paper No. **57—APM-29** (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

This paper contains a discussion of the velocities of propagation of long flexural and extensional waves in a plate or bar in the transition region between the states of generalized plane stress and plane strain; that is, for arbitrary width-thickness ratios (h/α) of rectangular sections. The investigations are carried out mathematically on the basis of approximate equations of motion. It is found that, for flexural waves, as h/α increases from zero, the velocity remains close to that for generalized plane stress until quite large values of h/α are reached, after which the velocity rises asymptotically toward that for plane strain. For extensional waves the velocity is slightly smaller than that for generalized plane stress for all $h/\alpha > 0$.

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Deformation of Elastic Paraboloid Shells of Revolution, by C. Nevin De Silva, Assoc. Mem. ASME, University of Michigan, Ann Arbor, Mich. 1957 ASME Applied Mechanics Summer Conference paper No. **57—APM-5** (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

This paper, using the contributions to the theory of shells of revolution given recently by Naghdi is concerned with the axisymmetric problem of thin elastic paraboloidal shells of revolution which includes the effect of transverse-shear deformation. Following the general scheme cited, an asymptotic solution is obtained for paraboloidal shells of uniform thickness and is valid at the apex of the shell. In the limit, these results reduce to the predictions of the classical theory of H. Reissner-Meissner. Solutions are given by both theories for a specific example, namely, a second-degree paraboloidal shell loaded uniformly over a small region about the apex when the open edge is clamped.

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Unsteady Flow of Gas Through a Semi-Infinite Porous Medium, by R. E. Kidder, California Research Corporation, La Habra, Calif. 1957 ASME Applied Mechanics Summer Conference paper No. **57—APM-13** (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

This paper presents an analytic solution to a problem of the transient flow of gas within a one-dimensional semi-infinite porous medium. A perturbation method, carried out to include terms of the second order, is employed to obtain a solution of the nonlinear partial differential equation describing the flow of gas. The zero-order term of the solution represents the solution of the linearized partial differential equation of gas flow in porous media given by Green and Wilts.

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Symmetrical Buckling of a Series of Uniformly Loaded Parallel Struts Supported by Spot Connections to a Long Thin Plate, by J. L. Cutcliffe, Robb Engineering Works, Amherst, Nova Scotia, Canada; and H. S. Heaps, Nova Scotia Technical College, Halifax, Canada. 1957 ASME Applied Mechanics Summer Conference paper No. **57—APM-7** (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

The deflection in buckling of a long panel consisting of parallel stiffeners across a rectangular plate is found when equal buckling loads are applied to the ends of each stiffener. The critical load for buckling is found as a function of the

elastic properties of the plate and the stiffeners for various spacings of stiffeners, and the number of spot connections to the plate.

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A Study of the Propagation of Flexural Waves in Elastic Beams, by E. A. Ripperger, Mem. ASME, University of Texas, Austin, Texas, and H. Norman Abramson, Assoc. Mem. ASME, Southwest Research Institute, San Antonio, Texas. 1957 ASME Applied Mechanics Summer Conference paper No. 57—APM-11 (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

EXPERIMENTAL results for flexural wave propagation in elastic beams of circular cross sections resulting from very sharp impacts are presented. It is noted that a well-defined wave system precedes the main pulse. The experimental results are correlated with theoretical predictions from both the Pochhammer-Chree and Timoshenko theories.

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Response of Nonlinearly Supported Spherical Boundaries to Shock Waves, by M. L. Baron, Assoc. Mem. ASME, Columbia University, New York, N. Y. 1957 ASME Applied Mechanics Summer Conference paper No. 57—APM-12 (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

AN INTEGRAL transform technique is used to solve a boundary-value problem in which the partial differential equation is linear but the associated boundary condition is nonlinear. A spherical cavity in an infinite acoustic medium has an elastically supported boundary such that the pressure-displacement relation on the boundary is nonlinear. The response of the boundary to a plane shock wave which progresses across the cavity and envelops it is obtained by solving two auxiliary boundary-value problems with linear boundary conditions. Using influence coefficients obtained from these solutions, a nonlinear integral equation for the response of the actual boundary is obtained. The integral equation is solved numerically for a set of parameters, and curves for the pressure-time and displacement-time responses of the boundary are presented.

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A Direct Method for Determining Airy Polynomial Stress Functions, by Ching-Yuan Neou, University of Bridgeport, Bridgeport, Conn. 1957 ASME Applied Mechanics Summer Conference paper No. 57—APM-2 (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

IN THIS paper a direct method for determining Airy polynomial stress functions is presented. Simplified procedures are developed for systematically reducing Airy stress functions expressed as doubly infinite power series to desired polynomial forms on the bases of compatibility and boundary conditions only, without resort to patching or guessing, as is necessary in the conventional superposition and "semi-inverse" methods.

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A Photoelastic Study of Strain Waves Caused by Cavitation, by G. W. Sutton, Assoc. Mem. ASME, General Electric Company, Philadelphia, Pa. 1957 ASME Applied Mechanics Summer Conference paper No. 57—APM-15 (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

ULTRA-high-speed photoelastic techniques have been applied to a study of the transient stresses and strains in a photoelastic plastic when subject to cavitation. A photocell, used to detect the transient strains, indicated that the time duration of the strains was about 2 microsec. Using an ultra-high-speed motion-picture camera, ultrasonic cavitation bubbles have been photographed collapsing on the surface of a photoelastic specimen, and the resulting strain wave in the solid has been photographed. The dynamic properties of a photoelastic material have been obtained in order to permit quantitative interpretation of the transients. This has indicated that the stresses due to cavitation may be as high as 2×10^5 psi. The photoelastic plastic, CR-39, was found to exhibit strain birefringence, and its strain-optic constant was found to be independent of the rate of loading.

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Motion and Stress of an Elastic Cable Due to Impact, by F. O. Ringleb, Naval Air Materiel Center, Philadelphia, Pa. 1957 ASME Applied Mechanics Summer Conference paper No. 57—APM-10 (in type; to be published in the *Journal of Applied Mechanics;* available to April 1, 1958).

THE motion and stress of an initially straight elastic cable one point of which suddenly moves with a constant vector velocity are studied. Formulas for the phase velocities of waves of constant stress and of waves of constant slope including the effect of initial tension and neglecting lateral contraction are derived. Under these assumptions exact and approximate relations between the impact stress and the distribution of energy in the cable are derived and discussed. The theoretical results are compared with results from tests on aircraft arresting gears carried out at the Naval Air Engineering Facility, Philadelphia, Pa.

Lubrication

Properties of Friction Materials—II, Theory of Vibration in Brakes, by P. R. Basford and S. B. Twiss, Chrysler Corporation, Detroit, Mich. 1957 ASME Semi-Annual Meeting paper No. 57—SA-97 (multilithographed; to be published in Trans. ASME; available to April 1, 1958).

A THEORY of vibration in brakes is developed, based on the statistical nature of friction. The conditions under which an incipient vibration can develop are shown to be (*a*), $4bm > a^2L^2$, where b = elastic constant of the lining in shear, m = mass per unit area, a = change in coefficient of friction with speed, and L = load force per unit area; and also, (*b*), $a < 0$. Whether noise will result from the vibration depends on how close the natural frequency of the lining $(4bm - a^2L^2)^{1/2}/(4\pi m)$ is to a frequency of the drum which can be excited by resonance. Observations on the relative noisiness of four kinds of lining were correlated with measurements of (*a*) and (*b*). When the linings are ranked in order of increasing tendency to noise as predicted by the theory, it is found that the order is the same as that observed in brake tests on road cars.

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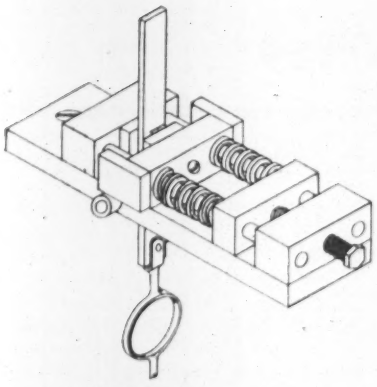
Properties of Friction Materials—I, Experiments on Variables Affecting Noise, by P. R. Basford and S. B. Twiss, Chrysler Corporation, Detroit, Mich. 1957 ASME Semi-Annual Meeting paper No. 57—SA-96 (multilithographed; to be published in Trans. ASME; available to April 1, 1958).

BRAKE linings and experimental methods for the study of their frictional properties are discussed in this paper. Measurements of the friction of various brake linings against polished iron have been made at speeds so low that surface temperature, known to be important at high speeds, could be neglected.

Test apparatus consisted of a specially ground iron or steel bar clamped between two samples of brake lining and pulled through at a predetermined rate. The bar was anchored through a strain ring to the fixed head of a Tinius Olsen tensile machine, while the sample fixture was mounted on the movable crosshead. Speeds between 0.025 and 12.4 ipm could be selected and maintained by means of a balanced thyratron circuit which controlled the driving motor. The normal (load) force on the sample was supplied by calibrated springs compressed by a screw-operated block.

The length of the springs under compression was used to measure the normal force. The output of the strain



Apparatus for friction measurement at low speeds between 0.025 and 12.4

gage was fed into a Brown recording potentiometer, which supplied a continuous record of the frictional force during a test.

The metal surfaces were not cleaned with solvents, nor was contact permitted with anything except the lining samples. They were stored in a desiccator when not in use. Under these conditions, the metal surfaces may be considered clean, except for the thin oxide films which always form in contact with air.

The coefficient of dynamic friction was lower than the static coefficient at the lowest speeds, increased markedly, and approached a constant value at the highest speeds studied, 12.5 ipm. Other apparatus was used to extend the range to 800 fpm. When the surface temperature was held constant, the friction coefficient passed through a broad maximum and thereafter decreased slightly as the speed was increased. The transition from smooth sliding to stick-slip friction was studied as a function of speed and load. A critical speed was found, above which only smooth sliding was possible, regardless of load. The time-force traces obtained during stick-slip motion supply information about the static coefficient, and also the elastic properties of the brake lining.

ASME Transactions

THE August, 1957, issue of the Transactions of the ASME (available at $1 per copy to members; $1.50 to nonmembers), contains the following technical papers:

Properties of Misaligned Journal Bearings, by G. B. DuBois, F. W. Ocvirk, and R. L. Wehe. (56—LUB-7)

Analysis of Journal Bearings With Arbitrary Load Vector, by O. Pinkus. (56—LUB-2)

The Fluid Dynamic Theory of Gas-Lubricated Bearings, by J. S. Ausman. (56—LUB-6)

Heat-Transfer Effects in Hydrostatic Thrust-Bearing Lubrication, by W. F. Hughes and J. F. Osterle. (56—LUB-11)

On the Theory of Grease-Lubricated Thrust Bearings, by A. Slibar and P. R. Paslay. (56—LUB-1)

Predominant-Peak Surface Roughness, a Criterion for Minimum Hydrodynamic Oil-Film Thickness of Short Journal Bearings, by L. F. Kreisle. (56—LUB-5)

Statistical Analysis of a Wear Process, by B. G. Rightmire. (56—LUB-10)

Testing Dynamically Loaded Bearings—I, by M. D. Hersey and R. B. Snapp. (56—LUB-3)

Testing Dynamically Loaded Bearings—II, by R. B. Snapp and M. D. Hersey. (56—LUB-4)

Universal Bearing Tester, by R. J. S. Pigott and B. R. Walsh. (56—LUB-9)

Cavitation Characteristics of Gate Valves and Globe Valves Used as Flow Regulators Under Heads Up to About 125 Feet, by J. W. Ball. (56—F-10)

A Comparison of Hydraulic and Pneumatic Accessory Power Generation, by E. I. Brown. (56—AV-23)

Drag-Turbine Performance, by O. E. Baljé. (56—AV-6)

Kinematic Analysis and Synthesis Using Collineation-Axis Equations, by W. J. Carter. (56—F-4)

On the Adiabatic Couette Flow of a Compressible Fluid, by W. F. Hughes and J. F. Osterle

Curved Beams With Eccentric Boundaries, by J. P. Vidosic, F. J. Bogardus, and J. C. Durden. (56—F-1)

Graphical Shoe-Brake Analysis, by G. A. G. Fazekas. (56—F-3)

Effects of Complex Stress-Time Cycles on the Fatigue Properties of Metals, by W. L. Starkey and S. M. Marco. (56—A-1)

Fatigue of Metals Under Combinations of Stresses, by W. N. Findley. (56—A-74)

Power From Solar Energy, by J. I. Yellott. (56—F-15)

Estimating Partial-Load Performance of Large Reheat Turbine-Generator Units, by S. D. Fulton and D. W. R. Morgan, Jr. (56—F-16)

Eight Years of Experience With Austenitic Steel Piping Materials at Elevated Steam Conditions, by F. P. Fairchild. (56—A-181)

Metallurgical Considerations of Main Steam Piping for High-Temperature, High-Pressure Service, by H. S. Blumberg. (56—A-157)

Austenitic Steels in High-Temperature Steam Piping, by R. M. Curran and A. W. Rankin. (56—A-217)

Engineering the Eddystone Plant for 5000-Lb 1200-Deg Steam, by J. H. Harlow. (56—A-165)

The Eddystone Superpressure Unit, by C. B. Campbell, C. C. Franck, Sr., and J. C. Spahr. (56—A-156)

Engineering the Eddystone Steam Generator for 5000-Psig, 1200-F Steam, by E. M. Powell. (56—A-164)

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Comments on Papers

Including Letters From Readers on Miscellaneous Subjects

Lignite

Comment by R. F. Throne[1]

REFERENCE is made in this paper[2] to several large units of Central Stations using Colorado so-called lignite in pulverized form.

Public Service Company of Colorado for over 50 years has burned Colorado "lignite" in its major steam-electric generating stations. So-called Colorado lignite is a low-grade bituminous or a high-grade lignite. The early Colorado Public Service installations were hand-fired flat grates and later followed by stoker equipment as it became available in a wide range of types. In 1924 pulverized equipment in a bin-system type was employed serving 100,000 lb steam/-hr boilers which system remains in operation serving later units of 300,000 lb steam/hr. In more recent plant projects the unit pulverizer arrangement is used serving boiler units ranging from 300,000 lb steam/hr to 1,000,000 lb steam/hr.

In this long experience we have one case of the definite comparison of a boiler installation that is an exact duplicate of an installation in Ohio, which in Ohio on its low-grade type of fuel gave a creditable performance, but which at 5000-ft elevation and burning Colorado lignite resulted in considerable attention to fireside deposits and a definite elevation of combustion gas temperatures. The ash-fusion temperatures are comparable, but the ash type and behavior is definitely worse in Colorado. Apparently, there is more to furnace design and proportioning than is represented by the proximate and ultimate analyses, ash-fusion temperatures, and grindabilities.

Reference is made in the paper to the effect of moisture on performance of equipment. There is a definite need to differentiate as to the type of moisture when dealing with the near-lignite type of fuel such as Colorado so-called lignite and the true lignites.

The Colorado experience indicates that the total moisture must be reduced to at least 18 per cent in order for the pulverized product to be free flowing and be properly handled by the burners. Any further reduction in moisture outside of the boiler furnace is not warranted and in fact is uneconomic. However, there is no established recognized testing procedure to our knowledge of classifying "external" moisture from "inherent" moisture. The present procedure is based on "room temperature" but the temperature of the room and the ambient humidity of the room air is not stated. At this altitude, humidity is quite low compared to most sea-level areas.

The moisture-degradation rate versus time of the Colorado lignite, regardless of its initial total moisture content, is a uniform smooth characteristic with no apparent break that might indicate the portion represented by "surface" moisture and that represented by inherent. However, it has been difficult to correlate operating experience when total moisture only is known.

Comment by W. M. Van Tassel[3]

The authors of this paper have performed a valuable service in directing attention to the significant advances in the utilization of a fuel which represents, on a heating value basis, 15 per cent of the total known coal reserves of this nation. Assured lignite reserves in the United States amount to over 463 billion tons. This is an important fuel resource that cannot be overlooked by our expanding and energy-hungry economy.

In briefly reviewing the history of the development of lignite utilization, the paper credits both manufacturing and operating organizations for the development of techniques required to utilize lignite. In this connection, it is worth noting that early lignite-using enterprises were small, both in economic structure and in physical plant. In recent years, these enterprises have grown considerably larger, justifying the costs of more intensive application of engineering talent, with the result that a great number of the problems which existed in early days of lignite use and which, unfortunately in many quarters are still presumed to exist, have been rather easily solved.

In addition to the credit properly due to the developments of manufacturers, operating organizations, and consulting engineers, it is proper to recognize the contributions of the lignite producers to the better utilization of their product. Improved methods of mine exploration and volume-production methods, such as stripping, have kept pace with increasing manpower costs, permitting production of a better selected and prepared fuel without appreciable cost increase per ton.

In North Dakota and South Dakota, mine-mouth lignite commands a price of 13.8 cents to 15 cents per million Btu. By most basic energy-production standards this is an attractive price, and the opinion of mine operators is that the figures quoted above are susceptible to reduction whenever the demand reaches proportions justifying larger scale and more highly mechanized methods.

The efficiency records of lignite-burning power plants reveals that the high-moisture content of this fuel does not appreciably detract from the favorable costs cited above for lignite used at mine mouth, but it is a major deterrent to long-distance volume shipment. Thus the high-moisture content is the basis for careful consideration of mine-mouth plants utilizing lignite at the point of production. We are all well aware of the fact that power-plant investment is, in usual practice, geared directly to fuel cost. Through traditional use of this yardstick, and insufficient regard for other factors, mine-mouth lignite-burning plants have, in general, been designed along lines that do not yield maximum fuel efficiency.

It appears that, in the case of lignite, certain factors other than the fuel cost should be examined in the selection of a

[1] Chief mechanical engineer, Public Service Company of Colorado, Denver, Colo. Mem. ASME.

[2] "Utilization of Lignite," by Earle C. Miller and C. Freeman Hawley, MECHANICAL ENGINEERING, vol. 78, January, 1957, pp. 23–26, condensed from ASME Paper No. 56—F-22.

[3] General superintendent of power production, Montana-Dakota Utilities, Bismarck, N. Dak.

plant design and investment. Whereas the high efficiencies usually associated with high-temperature, high-pressure power-plant designs cannot be justified by the mine-mouth fuel price, the usually applied criteria, it does seem likely that such high efficiency designs might be justified to accomplish the most efficient use of limited cooling water, which is characteristically scarce and of poor quality in the best lignite-producing areas. It is certainly conceivable that the cost of electrically transmitting mine-mouth produced power would be substantially less than the cost of shipping high-moisture lignite to a utilization point favored by an adequate and easily developed source of cooling water. It is further conceivable that this saving could justify the investment in a high-temperature, high-pressure multiple extraction, and possibly even reheat-power plant, which would put only 3 or 4 lbs of steam into the condenser for each kwhr produced, in place of the 10 to 22 lbs of steam per kwhr requiring condensing service at the mine-mouth lignite plants now operating. This phase of power-plant economics deserves further study.

This paper makes mention of the rapid load-acceptance capabilities of spreader-stoker fired lignite burning installations. Mention is also made of waterwall-furnace enclosures. It is not many years ago that everyone concerned with the design and operation of lignite plants felt that a refractory furnace was essential to promote ignition of the fuel on account of its high water content. Modern waterwall-furnace installations have conclusively proved that the ignition problem, at least in so far as spreader stokers and pulverizers are concerned, just does not exist. There are today, moderate pressure/temperature plants in service on North and South Dakota lignite with spreader-stoker firing into completely waterwall-enclosed furnaces that are capable of picking up from 25 per cent of rated capacity, instantaneously, to 125 per cent of rated capacity, with a loss in steam pressure of not over 5 per cent. The ignition problem, even with these extreme load-acceptance rates, is limited to the requirement that proper adjustments to the combustion-control apparatus will result in the furnace being supplied with excess air, rather than excess fuel, during the load-acceptance period.

The paper directs attention to the tendency of lignite fly ash to build up and accumulate on heat-exchange surfaces, hopper sides, and dust-collector components. These deposits may be roughly divided into two categories, specifically, the loosely adhering fly-ash deposits which are readily disturbed and removed by any mechanical force, and the harder but still somewhat spongy build-ups which occur even at moderate boiler ratings and are resilient and cannot be readily removed mechanically.

In the case of the loosely adhering fly-ash deposits, which have a very steep angle of repose and consequently cling to the sides of hoppers and dust-collector components, these build-ups can be kept from becoming troublesome by the use of electric vibrators operated intermittently and for short periods by a program clock.

The more solid deposits which usually appear on the heat-exchange surfaces from the waterwalls all the way through to the air heater, and on occasion, on the induced draft fan blades, do have a structural integrity and are bonded to the surfaces mentioned. These deposits, while in some cases quite hard, are not crystalline or glasslike in a sense similar to the crystalline or glasslike composition of the slag formed by bituminous coals. They are highly hygroscopic with a texture that could be described as between chalky and spongy.

Due to a lack of a crystalline structure there is little tendency for these deposits to build up and then drop off due to thermal shock. Effectively applied and properly used soot blowers are successful in keeping these deposits to a minimum, but in the normal course of events, the lignite fired boiler must eventually be taken off the line for fireside cleaning.

The results of hand-scraping or similar cleaning methods are disappointing. With hand-scraping methods, the base of the deposit is generally left on a large percentage of the surface being cleaned, and this base appears to have the property of serving as the foundation for a relatively rapid accumulation of new deposit during the subsequent operating period.

The most effective method of removing the spongy slag deposits is by water washing. This is best done, after the boiler and furnace are thoroughly cooled, by the insertion of spray pipes in the upper reaches of the furnace enclosure—tube banks or superheater, which spray pipes should deliver a relatively small quantity of water in an extremely fine spray. All furnace and boiler-setting doors and dampers should be closed as tightly as possible to develop the maximum relative humidity in the atmosphere within the furnace and flue-gas passages. Moving grates, and where possible, refractory surfaces should be protected by tarpaulins.

The fine spray-washing procedures should continue for 16 to 30 hours, and at the end of this period, it will generally be found that the fireside surfaces of the unit are as clean as they were when new.

Immediately after the completion of the washing, a slow drying fire should be started to gradually dry out the exposed refractory and drive away moisture that would otherwise tend to corrode boiler metal.

Different boiler designs require slightly different techniques, but experimentation will provide methods yielding fireside surfaces almost perfectly cleaned. It is absolutely essential that once the washing process is started, there be no interruption of sufficient duration to permit a drying out, or partial drying out of the deposits. These deposits have some of the characteristics of cement and if moistened and then dried out, are not subject to re-solution.

A marked advantage in the washing method is that it removes the fly-ash deposit right down to the tube metal. It has been noted that this clean metal surface is much less subject to the accumulation of deposit during the subsequent operating period. The build-up will again occur but, initially, at a much slower rate than the rate of build-up on a tube that is not thoroughly cleaned and presents a surface upon which there are a few thousandths of an inch of an old fly-ash deposit.

The utility of a fuel is affected by the ease with which it can be stored and handled. With proper equipment and methods of compaction, lignite can be successfully stored for indefinite periods. As with bituminous coals, good compaction is essential and this is easily accomplished with the compressible lignites. The principal storage-pile-maintenance problems are concerned with water and wind erosion, the first of which requires moderate slopes on the pile sides. Wind erosion can be effectively minimized by shelter-belt plantings around the storage area.

The characteristically high inherent moisture of lignite presents no serious problems in cold weather handling. However, surface moisture, accumulated from rain, snow, or production at poorly drained mines, can result in freezing problems even more troublesome than those encountered with washed bituminous coals shipped into cold climates.

Although lignite is a valuable re source in itself, it is well to note that uranium and other rare earth elements, such as germanium, have been found in many of the lignite seams of North and South Dakota. To date it appears that the occurrence of these rare earth elements is in noncommercial percentages, however, as the volume of lignite used

increases, those concerned with the utilization of lignite should be alert to the possibilities of concentrating these mineral resources in this fuel during the power production process. Research may determine methods of concentrating or isolating valuable by-products.

Authors' Closure

It is gratifying to have comments from operating people who have had the practical experience represented by Mr. Throne and Mr. Van Tassel. The statement by Mr. Throne that "there is more to furnace design and proportioning than represented by the analysis" cannot be too often emphasized in these days of trying to save engineering costs by duplicating designs which are sometimes totally inadequate.

Mr. Van Tassel's comments are quite complete and can hardly be improved. The authors are intrigued with his position that because of the location at lignite fields the cooling water is a major problem and can easily require high efficiency costs. This is a rather novel approach to justification of high efficiency and merits consideration. All operators of lignite plants will appreciate the detailed consideration of the cleaning problems.

E. C. Miller.[4]
C. F. Hawley.[5]

[4] Research engineer, Riley Stoker Corporation, Worcester, Mass.
[5] Chief mechanical engineer, Riley Stoker Corporation, Worcester, Mass.

Reviews of Books

And Notes on Books Received in Engineering Societies Library

Operations Research

INTRODUCTION TO OPERATIONS RESEARCH. By C. W. Churchman, R. L. Ackoff, and E. L. Arnoff. John Wiley & Sons, Inc., New York, N. Y., Chapman and Hall, Ltd., London, England, 1957. Cloth 6 × 9 in., figs., tables, bibliography, index, x and 645 pp., $12.

Reviewed by Robert E. Machol[1]

THE science, or art, of operations research was born at the beginning of World War II and an excellent book on the subject was written by Morse and Kimball at the end of the war and published a few years later. In 1951, in a review of this book, Bronowski wrote,[2] "Is there then a future for operations research today, either in industry or in war? I doubt it. . . What was new and speculative on the battlefield turns out, in the practical affairs of industry, to become only a painstaking combination of cost accounting, job analysis, time and motion study, and the general integration of plant flow. . . Operations research has done its major work."

It is a pleasure to report that Bronowski sounded the knell of O.R. too early. Whereas the Morse and Kimball book recounted triumphs in the military field only, the present book is loaded with examples of industrial applications; it is, in fact, based on many years of solid experience in solving industrial problems by the techniques described herein. It is clear therefore that O.R. has been and can be useful in industry; the only questions are whether O.R. is still in the ascendency, and whether this book is useful to those who wish to learn its mysteries and become practitioners of the art.

To the latter questions the answer is an unqualified "yes." Graduate students as well as those who call themselves (or wish to call themselves) O.R. men will want to study the entire book, paying particular attention to the middle 60 per cent, which is of a mathematical nature and develops some of the techniques which have proved useful. Management people will want to read the first seven and last three chapters—the 40 per cent which is largely nonmathematical. They will get from it some feel for what O.R. is and the kind of contribution it may be able to make. But they will probably come away with an incomplete and quizzical feeling. For this is a long way from the definitive book on the subject.

One weakness is the unevenness of coverage. This is to some extent inevitable where the chapters have been written by many authors, though the three principal authors have done an excellent job of bringing uniformity of tone and style to the entire work. The failure to decide on the mathematical level of the reader is more serious. Nominally the reader should have elementary calculus for the mathematical parts and no mathematics for the others. But we find three pages devoted to an extremely elementary discussion of the meaning of an inequality sign, and only a few pages farther on full-scale use of matrix notation and matrix algebra. It is true that the necessary definitions are supplied so that one could theoretically follow the matrix manipulations; but the level of mathematical maturity implied varies enormously.

The weakest portions of the book, however, are the nonmathematical. Sometimes the authors get bogged down in trivia: "There are two types of errors which can arise in the counting operation: *overenumeration* and *underenumeration*. Overenumeration results either from counting the same unit more than once or from counting units which should not be counted at all. Underenumeration, on the other hand, results. . ." and so on for two paragraphs. This sort of thing is excusable only when it leads to useful conclusions as a result of sophisticated re-examination of basic principles. Here the trivial discussion of counting merely trails off with the equally trivial conclusion that "it is desirable to design the best conceivable counting procedure." The difficulty is in attempting to put into words the understanding and experience which the authors undoubtedly have in their minds. And the basic cause of the failure appears to be lack of understanding of the structure of this science of O.R. Early in the book the authors state that "The terms 'tools,' 'techniques,' and 'methods,' which are frequently used interchangeably in science, are carefully differentiated here. . . calculus is a scientific tool; employing

[1] Operations research and system analysis, Engineering Research Institute, The University of Michigan, Ann Arbor, Mich.
[2] J. Bronowski, *Scientific American*, vol. 185, October, 1951, pp. 75–77.

calculus to find an optimum value of a variable in a mathematical model of a system is a scientific technique; the plan of utilizing a mathematical model to optimize a system is a scientific method." The distinction seems far from clear-cut, and falls apart completely before the book is finished.

The fact of the matter is that the authors do not know exactly what are the tools, the techniques, or the methods of O.R. They do not even know what O.R. is. This is not their fault. Morse, who is as much an expert as anyone, has recently said,[3] "Most of the time of . . .conferences on operations research is taken up with attempts to define operations research and to persuade others to try it." He might have added that operations researchers spend a lot of time saying how scientific they are. In chapter 3 of the present book is a story of an attitude survey conducted by an O.R. team with useful results. The author assures us that "attitude determination is a very tricky business, and one that should be entrusted only to competent professionals." The result of the survey was that 136 out of the 150 workers interviewed complained that their chairs were uncomfortable. New chairs were supplied, and performance improved. It would seem that with this overwhelmingly prevalent attitude, no great sophistication of technique would be required to find it, yet the author's conclusion is, "This is an example of the way in which scientific techniques can, in the hands of experts, provide factual data on which management decisions may be based." In the space of eight pages in this chapter, the word "scientific" is used ten times, always in this same sort of context.

[3] P. M. Morse, *Physics Today*, vol. 8, September, 1955. p. 14.

Though this is the weakest chapter in the entire book, the same sort of self-conscious assertion of "scientificness" is found throughout. Often it seems forced: "Just as currents and voltages are measured in electric circuits, quantitative measurements of 'interaction' in social groups—and machines for obtaining such measurements—have been made in certain experimental situations."

No concise definition of O.R. is given in this book, and it would be unreasonable to expect one. Yet one might hope for an implied definition, which somehow fails to come through. O.R., we are told, is the application of the scientific method by interdisciplinary teams of scientists, supplying the basis for executive decision. But the kind of problem on which the team works is not made clear. One gets the opinion that an O.R. man is one who is an expert on other people's problems. The crux of the matter is brought out not in this book, but in remarks made elsewhere[4] by the senior author: "It is amazing that 90 per cent of the work in O.R. is the gathering of cost information. Not just for new businesses, but for old businesses as well, the really important cost information does not exist. For example, any outsider can see immediately that the data most relevant to running a railroad isn't collected. Railroads don't know the relative costs of hauling different commodities. Railroads have never even determined how long a train should be. . . . I don't know of a single company that collects the proper data on the total time required to process products. It is impossible to state whether cutting delays from 90 to 60 days is worthwhile."

[4] Notes taken by J. Hoagbin from a lecture by C. W. Churchman at The University of Michigan on December 5, 1956.

And so what O.R. really is is a point of view that enables one (not "any outsider," but any O.R. man) to determine the relevant data. Cost accounting has been developed in business to a high degree, but oriented to fiscal policies rather than production policies. The O.R. man can go in and ask simple questions which have never been properly formulated before—questions mostly about marginal or comparative costs—and then answer them with comparative ease. This is likely to lead to a small percentage increase in profit (or decrease in cost), and if the operation is a large one, the absolute value of the profit increase may be impressive. There is gold lying about to be plucked, and the O.R. teams are plucking it. As Bronowski said,[2] "the field of opportunity will never again be quite so blank, so simple, and so lavish." It seems inevitable that businessmen will learn the word "optimize" and the simple tricks which the O.R. men are teaching them. And then the O.R. team, as distinguished from ordinary business control personnel or management consultants, will cease to have a function.

And so perhaps Bronowski was right after all when he said[2] that the major work of O.R. "turns out to have been a piece of education—the education of scientists and warriors in a new empiricism." The O.R. man has stretched his triumphs for a decade by invading industry, but operations research as a separate discipline seems foredoomed unless something more can be synthesized than is apparent in this book. The techniques described in this book are valid and they will be used, but perhaps not most efficiently by professional O.R. men. If O.R. is to continue to grow, it will need to take on a more constructive and coherent aspect.

Books Received in Library

ASTM Methods for Chemical Analysis of Metals. Published 1956 by the American Society for Testing Materials, Philadelphia, Pa. 627 p., 6 × 9¼ in., bound. $8. This publication is a part of the Book of ASTM Standards and complements parts 1 and 2 which cover the metals. It contains all ASTM methods for chemical analysis of ferrous and nonferrous metals and alloys, including spectrochemical analysis. There are ten completely new methods and recommended procedures including chemical analyses for electronic nickel and titanium. In addition, ten standards have been substantially revised. Diagrams of the apparatus and pertinent charts have been included in some cases.

American Power Conference Proceedings. Vol. 18, 1956. Illinois Institute of Technology, Technology Center, Chicago, Ill. 665 p., 9¼ × 6 in., bound. $8. The present volume of this annual publication features a nuclear energy forum at which some of the broader aspects of nuclear power development were considered: the role of industry and of government, research tasks, etc. The papers delivered at the regular sessions—mechanical, electrical, nuclear energy, and water technology—are devoted to a wide range of subjects, including supercharged boiler design, fly ash and slag, air pollution, high-temperature, high-pressure power generation, 300–3000 cycle power in industry, digital computers for power system analysis, and ion exchange membranes for water conditioning. Various aspects of corrosion are treated in a group of five papers delivered at a special symposium.

American Wood-Preservers' Association Manual of Recommended Practice. Revised Edition, 1956. Published by The Association, Washington, D. C. Various pagings, 4¾ × 7¼ in., ring note-book. Price not given. A practical manual of standards for those who are concerned with the processing of lumber or its use in construction. The publication is divided into six sections: The index; preservatives; treated products; analysis methods; miscellaneous instructions and tests; and conversion factors and correction tables.

Annual Review of Nuclear Science. Vol. 6. Edited by J. G. Beckerley and others. 1956, Annual Reviews, Inc., Palo Alto, Calif. 471 p., 6 × 9 in., bound. $7. The present volume contains reviews of advances, and of

the literature on 13 topics. One of the papers deals with reactors for power generation, the remainder with such specialized subjects as time variations of primary cosmic rays, nuclear radiation effects in solids, low-level counting techniques, and applications of oxygen isotopes in chemical studies.

ARCS IN INERT ATMOSPHERES AND VACUUM. Electrochemical Society Symposium, San Francisco, Calif. May, 1956. Edited by W. E. Kuhn. 1956, John Wiley and Sons, Inc., New York, N. Y. 188 p., 8½ × 11 in., bound. $7.50. Fundamentals, design and operation of furnaces, and chemical applications are the major phases of arc technology covered. Papers on furnaces deal with vacuum arc melting of refractory metals; a pilot-model three-phase consumable-electrode arc furnace; electrode control systems; vacuum remelting of superalloys and steels; and German developments in vacuum arc melting of titanium and zirconium. Papers on applications deal with applications of the high intensity arc in metallurgy and in process chemistry, and with energy transfer in the high intensity arc.

DOCUMENTATION IN ACTION. Edited by J. H. Shera and others. 1956, Reinhold Publishing Corporation, New York, N. Y. 471 p., 6 × 9¼ in., bound. $10. A record of the 1956 Western Reserve Conference on the "Practical Utilization of Recorded Knowledge —Present and Future." The proceedings are presented in five main parts: present requirements, methods and problems; programs for the future; discussion of information processing including the use of recorded information in research, information theory, and retrieval of recorded information; establishment of co-operative programs; and definition of research areas (a summary). Terminology problems, machine translation, automatic processing, and other special aspects are considered.

ELASTICITY, FRACTURE AND FLOW; with engineering and geological applications. By J. C. Jaeger. 1956, John Wiley and Sons, Inc., New York, N. Y. 152 p., 4¾ × 7½ in., bound. $2.50. This is a concise exposition, for engineers and geologists, of the basic mathematics of the theories of elasticity, plasticity, viscosity, and rheology. The book is comprised of three chapters devoted to the detailed analysis of stress and strain; the behavior of materials (including criteria for fracture and yield); and the equations of motion and equilibrium.

ENGINEERING USES OF RUBBER. Edited by A. T. McPherson and A. Klemin. 1956, Reinhold Publishing Corporation, New York, N. Y. 490 p., 6 × 9¼ in., bound. $12.50. A text and reference work for engineers outside the rubber industry who use rubber for applications in other fields. Consisting of 16 chapters by 18 rubber technologists, the book deals with methods of manufacturing rubber goods; properties; means of obtaining rubber products through purchase by specification or by special construction; and uses in electrical, civil, and chemical engineering. Also treated are the design of mountings, tires, belt conveyers, rubber in automobiles, and rubber in aviation. The book concludes with a brief discussion of the molecular structure and mechanical properties of rubber.

GAS DYNAMICS. By Klaus Oswatitsch. English version by Gustav Kuerti. 1956, Academic Press, Inc., New York, N. Y. 610 p., 6 × 9½ in., bound. $12. This is a thorough account of fundamentals, combined with a survey of advanced methods of analysis. The main subjects covered are the thermodynamics of gas particles; steady and unsteady one-dimensional flow; the theorems and general equation of the mechanics of compressible fluids; equations and solutions for steady inviscid flow; subsonic, supersonic, and transonic flow; steady and unsteady three-dimensional flow; and viscous flow. The last chapter deals with experimental techniques, mainly for steady flow measurement.

HIGH TEMPERATURE—A TOOL FOR THE FUTURE. Proceedings of a symposium, Berkeley, Calif., June, 1956. Published 1956 by Stanford Research Institute, Menlo Park, California. 218 p., 8½ × 11 in., bound. $5. The 36 papers included are about evenly divided among three major subjects: methods for obtaining high temperatures, materials for containing high temperatures, and processes occurring at high temperatures. The methods treated include solar furnaces, the carbon-arc image furnace, short time electrical discharges, induction and resistance heating, chemical methods, and nuclear methods. Papers devoted to materials deal with ductile ceramics, refractory coatings, selection of materials, and the interactions of materials with high-temperature environments. Gas and condensed state reactions, and the interactions between gases and condensed phases are the chief processes discussed.

DIE KORROSION DES EISENS UND IHRE VERHUTUNG. By H. Klas and H. Steinrath. 1956, Verlag Stahleisen, Dusseldorf, Germany. 504 p., 6¼ × 9¼ in., bound. DM 55.00. A monograph on the corrosion of iron and steel and its prevention, for the metalworking industry and the industrial user. The book covers basic theory, properties of iron and steel, corrosion as an engineering problem, corrosion testing, selection of materials to avoid corrosion, inhibitors and cathodic protection, protective coatings and other surface treatments. A bibliography of over 1300 references is appended.

LUBRICATION OF BEARINGS. By F. T. Barwell. 1956, Butterworths Scientific Publications, London, England. 292 p., 5⅓ × 8¾ in., bound. $10. A compact presentation of data drawn from significant work published in the last 50 years. Intended to aid the practicing engineer in the design of bearings, the book covers the nature of surfaces, wear, viscosity, and other fundamentals, outlines the principles of hydrodynamic lubrication, and presents a tentative approach to design. Thrust bearings, concentrated contact bearings, externally pressurized bearings, and oscillating bearings are covered.

THE MATHEMATICS OF DIFFUSION. By J. Crank. 1956, Oxford University Press, New York, N. Y. 347 p., 6 × 9½ in., bound. $8. The early part of this treatise is developed from "Conduction of Heat in Solids" by Carslaw and Jaeger. The author selects some of their solutions of the heat conduction equation which he thinks can be applied to diffusion when the diffusion coefficient is constant. He evaluates them numerically and presents them in graphical form. Derivations of the solutions are included. The latter part of the book is about systems in which the diffusion constant is variable. Various methods of numerical and graphical solution are indicated. The final chapter deals with temperature changes which may accompany diffusion.

THE NATIONAL FIRE CODES. Vol. 5. Electrical. Revised to July, 1956. Published 1956 by the National Fire Protection Association, Boston, Mass. Various pagings, 5½ × 8¾ in., bound. $6. This volume contains the text of the National Electrical Code which gives the basic minimum provisions considered necessary for safety for wiring design, materials, and methods; motors, generators, capacitors, and other equipment; hazardous locations, bulk storage plants, garages, etc.; cranes, elevators, induction heating, machine tools, and other special equipment, emergency systems; communication circuits; and radio and television equipment. The volume also includes standards on electrical fire alarm and supervisory services, lightning protection, and static electricity. References are made to electrical provisions of other NFPA standards.

ON HUMAN COMMUNICATION. By Colin Cherry. 1957, John Wiley & Sons, Inc., New York, N. Y. 333 p., 5⅞ × 9¼ in., bound. $6.75. A group of essays introducing a new series, "Studies in Communication," which will appear during the next few years. It is not a mathematical exposition of the theory of communication, but a reasoned appraisal of the relationships existing between the diverse studies of communication. Although chiefly concerned with linguistics and information theory, much of the content and discussion can be useful to the telecommunication engineer or the researcher in machine documentation.

PROGRESS IN NUCLEAR ENERGY. Series 5. Metallurgy and Fuels. Edited by H. M. Finniston and J. P. Howe. 1956, McGraw-Hill Book Co., Inc., New York, N. Y. 805 p., 6 × 9¼ in., bound. $21. The first volume in this series consists of individual papers grouped under nine major divisions: production and preparation of uranium; thorium; beryllium and zirconium; physical metallurgy of plutonium; preparation and properties of rare earths; ceramics; fuel elements; irradiation effects; and solid state physics. The papers deal with a wide range of metallurgical problems involved in the production of serviceable fuel elements, coolants, and moderators for reactors.

PUMP SELECTION AND APPLICATION. By Tyler G. Hicks. 1957, McGraw-Hill Book Company, Inc., New York, N. Y. 422 p., 6 × 9¼ in., bound. $8.50. The first 60 pages of this practical manual describe the classes and types of modern industrial pumps, emphasizing what can be expected from each type. The remainder of the book is about equally divided into two sections, the first a detailed consideration of factors in pump selection—head, capacity, liquid handled, etc.,—the second a series of specific discussions of pumps used in more than a score of industries including power, petroleum, nuclear energy, water supply, sewage, irrigation, and mining.

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Roundup

Of Current Engineering Events, News, and Comment

E. S. Newman, *News Editor*

Classroom First Line of Defense in Fight to Wipe Out Engineering Manpower Shortage

Industry-Education Conference and ASME Forum on Education Seek to Encourage Young People to Prepare for Careers in Engineering and Science

DURING June and July California was the scene of two highly significant conferences devoted to stamping out the shortage of engineers and scientists so vitally needed to maintain the supremacy of the United States in the cold war.

"The shortage of scientists and engineers can ultimately be solved only in the local classroom," said Robert L. Clark executive secretary of the President's Committee on Scientists and Engineers, in discussing the need for improved teaching of science courses from grade school through junior college.

▶Industry Takes Action

Mr. Clark was one of the authorities who addressed the 100 national leaders representing science, education, and industry, assembled for the Industry-Education Conference held July 7–13 at the University of California's new extension conference center at Lake Arrowhead, Calif., near Los Angeles. The Conference was under the joint sponsorship of the National Academy of Sciences, Washington, D. C., and the Hughes Aircraft Company, Culver City, Calif.

The conference, at closing time, showed that four major steps had been taken as a result of deep probing discussions and marshalling of facts. The Southern California Industry-Education Council (SCIEC) had been established including an executive secretary and a five-man steering committee. Five "salesmen" within the Southern California area had been appointed to enroll more industries and schools in the programs to improve science teaching. An industry fund-raising drive was accepted for the operation of the SCIEC and informal assurance quickly received from industrial delegates. The résumé of achievement also included an agreement to publish a manual, sponsored by the National Academy of Sciences, to show other areas how to start their own industry-education co-operation programs.

The Council chose as its first executive secretary, James T. Robinson, a brilliant Whittier, Calif., high-school science teacher, 34 years old, with a knack of

J. T. Robinson, *left,* executive secretary of new Southern California Industry-Education Council (SCIEC), checks reports at Industry-Education Conference, July 7–13, Lake Arrowhead, Calif. Continuing *bottom left,* Dr. J. B. Platt, president, Harvey Mudd College, Claremont, Calif., acts as chairman of final session of program designed to overcome scientific manpower shortage through industry-education co-operation. Dr. George Berry, *right,* dean, Harvard University medical school, urges a broad, liberal education for future scientists and engineers. Meeting cosponsors were National Academy of Sciences and Hughes Aircraft Company.

Forum on Education held during ASME Semi-Annual Meeting with ASME members and guest educators, from San Francisco area, kicked off a series of meetings planned to evolve a plan to wipe out the shortage of scientific and engineering personnel. Left photo, standing, *left to right:* Wallace Andrews, Drake High School; R. L. Goetzenberger, ASME, Washington, D. C.; R. Lannert Iglehart, chairman, ASME Forum, chief engineer, Shell Development, Emeryville, Calif.; R. J. Palmer, Tamalpias High School; R. H. Prather, Drake High School; Mrs. Adrian Cobb, Tamalpias High School; J. Calvin Brown, past-president, ASME, Los Angeles; and Miss Eunice Reader, Tamalpias Union High-School District, Marin County, Calif. Right photo, seated, *left to right:* Louis Alcorta, vice-president, Northern California Section, California Science Teachers Association; Dr. P. De H. Hurd, Stanford University; Eugene Roberts, San Francisco Polytechnic High School; and E. W. Jacobson, director, ASME, Pittsburgh, Pa. Standing, *left to right:* E. O. Bergman, director, ASME, Alhambra, Calif.; V. Weaver Smith, director, ASME, New York City; A. K. Oppenheim, Mem. ASME, president, Northern California Section, American Rocket Society; and W. E. Reaser, assistant secretary, ASME, New York, N. Y.

distilling complex scientific principles into simple language.

Mr. Robinson will serve the Council until the middle of September when he will leave to study at Stanford University on a National Science Foundation scholarship.

Thus when his successor takes over this fast-moving Council's steering committee expects the industry-education co-operation program to be well under way.

In an atmosphere of mutual understanding, the educators and industrialists at the conference compared notes and found both wanted to help each other to make science teaching come alive through demonstrations of the practical applications of scientific theory, and that the "future scientists and engineers" have the best training in nontechnical as well as technical subjects to help them think big and then be capable of communicating their ideas to others.

The newly established Council, to live up to general expectation, will serve as a catalyst for increased industry-education co-operation and as a clearinghouse where industry and education can make contact with one another to plan new point projects.

Foremost, among the several regional industry-education programs described at the conference, was the one conducted by Hughes Aircraft Company. In addition to sponsoring college-level courses and scholarships for more than a 1000 of its own employees, the company has a co-operative program with the Los Angeles schools. The Hughes program is managed in three parts in the following manner:

A summer-employment program for high-school science and mathematics teachers that enables them to work side by side with top-level Hughes scientists, gaining first-hand knowledge of practical applications of the classroom theory that they teach during the school year.

Lectures to high-school science classes by Hughes scientists, bringing students up-to-date on the latest scientific developments and stimulating their interest in scientific careers.

A summer research project in the Hughes laboratories for outstanding high-school students, giving them first-hand experience in scientific work as it is carried on by industry.

SCIEC, progressing at a rapid pace, paused long enough at the conclusion of the conference to make this prediction: That by September, from Fresno to San Diego, the industry-education co-operation program would be showing the results of a wide, successful chain reaction that would not remain limited to teamwork on improved teaching of science. When industrialists and educators get to know one another better, there will be more and more opportunities to expand their co-operation to other fields. But, the first step is toward the upgrading of the entire educational system.

▶ASME Plots a Course

In California the North and South agree.

They agree that the classrooms across the nation are where the solution will be found to the current engineering and scientific manpower shortage. Means must be made available to aid in the improvement of the teaching of science in the high schools, to better equip teachers and vocational counselors to guide and encourage promising students into careers in engineering and science, and to make these young people aware of industry's role in shaping our way of life.

More than this, it is agreed that any program to succeed must have the personal participation of men in the profession.

▶The American Society of Mechanical Engineers has long been interested in the problem and has taken a leading part in many projects designed to alleviate it.

To foster widespread interest and action, the Society sponsored a forum during the 1957 Semi-Annual Meeting, in San Francisco, at which a representative group of educators was asked the question, "In what ways can we assist in encouraging and training future engineers and scientists in the secondary schools?"

This meeting to plot a straight course was so successful that it has generated a series of five subsequent meetings which

resulted in an important set of recommendations.

The day-long program for members of the Society with high-school guidance counselors and science teachers and college faculty opened with a seminar dealing with trends in engineering education. ASME President W. F. Ryan joined the group to discuss mutual problems of science teaching and guidance; later, speaking at the President's Luncheon, on a survey of the engineering profession. In the afternoon the group continued to "brainstorm" in a seminar devoted to finding out how a young engineer can develop professionally. The day's activities closed with some very lively discussions with ASME national, regional, and local officers at an informal tea. Co-ordinator of the program was R. Lannert Iglehart.

In an atmosphere of mutual interest, President Ryan, whose outstanding career in engineering justly makes him an enthusiastic booster of the profession, served the meeting well as an enlightened "guidance counselor."

He made three specific suggestions.

He urged that students should be encouraged to consider engineering careers before they enter high school. As a matter of fact, he believes that it is not too early to guide youngsters in the fifth through the ninth grades toward a career in engineering.

Further, he strongly endorsed a curriculum for potential engineers, now in junior and senior high schools, that is well larded with generous portions of the humanities.

Dr. Ryan also recommended that more women be welcomed into the profession as full-fledged engineers.

With this program as a starter, the San Francisco Section held a series of conferences which resulted in recommendations that, when successfully carried out, will markedly help eradicate the shortage.

Working together with other professional societies and organizations, the ASME recommends continued and expanded efforts to aid in the improvement of our educational system, particularly in the secondary schools.

To implement this policy, a special committee of the local section will be appointed with responsibility for directing and co-ordinating all the Section's activities related to educational matters. The committee's scope should include education at all levels and not be restricted to the secondary schools.

This special committee should avail itself of the services of an advisory group of educators from its immediate area.

The first project of this committee, it was recommended, should be the appointment from the Section membership of an ASME sponsor or liaison representative for each high school in the area, the function of the sponsor being to provide the essential personal relationship between ASME and the school. His duties would include advising the school of the committee's activities, informing the committee of the teachers' needs and problems, and providing direct assistance to the school's science and mathematics teachers in such projects as arranging for loans or gifts of materials and equipment, access to special facilities, and technical consultation as required.

The Section should pursue a policy of inviting educators, particularly science and mathematics teachers and guidance counselors, to ASME meetings and appropriate activities, thereby instituting mutual reciprocity. The educator gives a deeper thought to the nature of the engineering profession and the ASME members get a more personal understanding of the Teachers' and schools' problems.

The sponsors and special committee should become familiar with the services available from local groups, such as the Engineers Joint Council and the local Science Fair, and from other national groups, such as the ECPD, in order to integrate effectively the section program with these services. This would not only eliminate any duplication of effort but also be using their experience and ideas to the best advantage.

Thus, two plans were launched in California to use the combined efforts of the profession itself, industry, education, and Government agency to help keep our country strong in our way of life.

IEC Joins Many Nations at Moscow

U. S. Delegates to Moscow Meeting inspected plants, attended conferences, and saw something of Russian life

"Russian advances in electrotechnology and hydroelectric power represent surprising accomplishments," said Richard C. Sogge of General Electric Company. Mr. Sogge is leader of the 24-man U. S. delegation which recently returned from an 11-day meeting in Moscow of the International Electrotechnical Commission (IEC). He made his comments at a press conference held in the offices of the American Standards Association, New York, N. Y.

Mr. Sogge is president of the U. S. National Committee of the IEC, which is an arm of the American Standards Association.

Delegates from 27 countries, totaling more than 500, attended the annual meeting of the IEC. Sixteen technical committees were in session during the July 2–12 Moscow meetings.

Mr. Sogge said that the Russians are planning a 1000-mile d-c transmission line connecting Moscow with power sources in Siberia. In addition, 400-kv power circuits are in operation, he said. U. S. delegates were told that Russia has turbogenerators rated at 150,000 kva in operation and is building them with 200,000-kva rating.

It was noticeable that some of the equipment in Russian plants they visited was much older than ours, but appeared to be in good running condition. The concensus of the U. S. delegation is that accident prevention and plant housekeeping were not as advanced as in U. S. industry, Mr. Sogge reported.

International Standards Reported

The central committee of the IEC, with headquarters in Geneva, Switzerland, reports that 16 draft international standards have been received. "Numerous proposals were made by various countries which no doubt will go into international standards," Mr. Sogge said.

These will be considered by technical committees at future IEC meetings.

Other observations of industrial prac-

A meeting of the Technical Committee on Switchgear and Controlgear, TC 17 held during the Moscow meetings of the International Electrotechnical Commission (IEC), July 2–12. American delegates are, second row, *left to right*, C. H. Linder, vice-president—engineering, General Electric Company; L. W. Cole, chairman of the board, Federal Pacific Electric Company; and G. W. Heumann, General Electric Company.

At the meeting of the International Electrotechnical Commission, July 2–12, *left to right*, G. Vovchenko, pro-rector of Moscow University; Percy Dunsheath, IEC president; A. Pavlenko, Russia's Minister of Power, who was chairman of the Organizational Committee of the Moscow meetings, and D. Chizhov, deputy minister of Power and vice-chairman of the committee

A group of participants in the Moscow Session of the International Electrotechnical Commission visited the Moscow Power Institute. Guests shown in the electrical machines and apparatus hall of the General Electrotechnical Laboratory.

tices in the U.S.S.R. were made by various members of the U. S. delegation who saw large electrical apparatus plants, transformer works, automobile factories, and radio tube plants. Technical inspections were made at plants in Moscow, Leningrad, and Zaporozhye. While at Leningrad, the Americans toured the Direct Current Research Institute. Zaporozhye is the site of the prewar Dniepropetrovsk installation.

"We were all surprised," Mr. Sogge commented, "that the communists were so free in showing us installations of real interest to our technical group. Also, we were constantly being asked for criticism of what we saw."

"English was the language used 99 per cent of the time at the meetings. English, as a matter of fact, has supplanted German as a second language. The Soviets supported the U. S. viewpoint in nearly all of the meetings," Mr. Sogge stated.

Russians Seek Meeting With Electrical Engineers

S. David Hoffman of the American Standards Association, who was one of the U. S. delegates, reported he was asked to explore the exchange of electrical engineers and technicians between the U. S. and U.S.S.R. This inquiry was made by Nikolai P. Galochkin, chief of the department of foreign relations and A. Nekrosov, chief of technical department, both of the ministry of power stations.

A. S. Pavlenko, minister of power stations, was chairman of the U.S.S.R. organizing committee and headed up the arrangements for the event. This was one of the first official duties of Mr. Pavlenko as successor to the deposed Georgi Malenkov. Nowhere did the Russians try to use the meetings for a political platform, Mr. Sogge observed. He added that the U.S.S.R. followed the U. S. practice of having only one delegate speak for its national committee at each meeting. On the whole the Russians conducted the meeting ably and with facility. The technical people were qualified, anxious to discuss many topics, especially those pertaining to the U. S.

Other officers of the U. S. National Committee who attended the meetings were: Hendley Blackmon, Mem. ASME, Westinghouse Electric Corporation, vice-president of the USNC; S. David Hoffman, American Standards Association, secretary of USNC; and Vice-Admiral George F. Hussey, Jr., USN (ret.), Mem. ASME, American Standards Association, treasurer of USNC.

The IEC was organized in St. Louis in 1904, at a world meeting of electrical engineers and manufacturers of electrical products. The 50th meeting of the IEC, the second meeting to be held in the U. S., met in Philadelphia in 1954. Last year's general meeting of IEC was held in Munich, Germany. Stockholm, Sweden, will be the site of the 1958 annual meeting. A tentative invitation was extended to have the group hold its 1959 meeting at Madrid, Spain.

The 16 technical committee meetings held during the 11 days were on rotating machinery, electric traction equipment, switchgear and controlgear, cables, lamps and lighting, bushings, semi-conductor rectifiers, and lightning arresters.

The Russians organized a special program of events for the women which included shopping tours, fashion shows, and visits to the Lenin State Library, art museums, and ballet at the Bolshoi National Theatre.

U. S. Delegates

Besides the officers of the United States National Committee, U. S. delegates to the meeting were H. S. Osborne, consultant (formerly American Telephone and Telegraph, and past-president, IEC); L. W. Cole, Federal Pacific Electric Company; E. F. W. Beck, Westinghouse Electric Corporation; E. V. DeBlieux, General Electric Company; C. L. Dawes, Harvard University; J. H. Foote, Commonwealth Associates, Inc; G. W. Heumann, General Electric Company; E. A. Harty, General Electric Company; L. F. Hunt, Southern California Edison Company; J. G. Hutton, General Electric Company; W. M. Leeds, Westinghouse Electric Corporation; G. F. Lincks General Electric Company; C. H. Linder, Mem. ASME, General Electric Company, W. P. Lowell, Jr., Sylvania Electric Products, Inc.; J. W. May, ITE Circuit Breaker Company; L. W. Morton, General Electric Company; I. R. Smith, Westinghouse Electric Corporation; F. Ullman, Westinghouse Electric International Company; R. F. Wolfe, National Carbon Company; and W. F. Doxey, United States Army Signal Engineering Laboratory.

The IEC endeavors to provide common terminology and standards in lighting, power, communications, and electronics to facilitate international trade.

The United States National Committee provides the means for the electrical industry of the U. S. to keep informed and take part in the development of international specifications use in world marketing of their products.

Nuclear Energy Standards ISO Topic in Geneva

Six areas of work plotted, including glossary, symbols, and safe design

The first steps toward world standardization for peaceful use of nuclear energy were taken by 61 delegates from 13 countries at a meeting of the International Organization for Standardization (ISO), Geneva, Switzerland, July 30 to August 1. Results of the meeting were reported August 6 by the American Standards Association, U. S. member of the 38-country organization.

Six Areas of Work

Under the chairmanship of Morehead Patterson, Mem. ASME, president, American Machine and Foundry Company, New York, N. Y., the first meeting of ISO Technical Committee 85 on Nuclear Energy outlined six areas of work. They are:

1 Development of a tri-lingual glossary of terms applicable to nuclear energy and based on work already done in various countries.

2 Development and approval of a warning symbol for use wherever danger from ionizing radiation is present.

3 Adoption of units pertaining to nuclear energy, which were developed by the International Commission on Radiation Protection and the International

Commission on Radiological Units.

4 Development of symbols required for drawings pertaining to nuclear equipment and installations.

5 Development of international recommendations relating to measurement of radiation and protection against radiation.

6 Development of internationally acceptable guides for safe design, operation, and maintenance of nuclear reactors.

The United States holds the secretariat of the committee through the American Standards Association. The ASA accredited 15 delegates to represent the U. S. at the meeting. Vice-Admiral W. A. Kitts, 3rd, USN (ret.), General Electric Company, headed the U. S. delegation. Vice-Admiral G. F. Hussey, Jr., managing director of the American Standards Association, was secretary of the delegation and also of the meeting.

All work of the technical committee and its subcommittees will take account of work already done by national and international organizations to the end that there may be no unnecessary duplication of efforts, according to a statement of results prepared by the ISO. The ISO work covers the same basic areas as the standards program now going on in the U.S. under the procedures of the American Standards Association.

U. S. Delegates

U. S. delegates to the international conference were: R. C. Dalzell, U. S. Atomic Energy Commission; General O. J. Gatchell, USA (ret.), Member-at-Large, American Machine and Foundry Company; Daniel F. Hayes, American Society of Safety Engineers, U. S. Atomic Energy Commission; Vice-Admiral Kitts, Atomic Industrial Forum, General Electric Company; Morris Kleinfeld, International Association of Governmental Labor Officials, Division of Industrial Hygiene and Safety Standards, New York Department of Labor; G. M. Muschamp, Fellow ASME, Scientific Apparatus Makers Association, Brown Instruments Division, Minneapolis-Honeywell Regulator; Morehead Patterson; Lauriston S. Taylor, National Bureau of Standards; Harvey Wagner, The American Society of Mechanical Engineers, The Detroit Edison Company; C. R. Williams, National Association of Mutual Casualty Companies, Liberty Mutual Insurance Company; W. A. McAdams, Health Physics Society, General Electric Company; Vice-Admiral Hussey and Henry G. Lamb, American Standards Association; E. C. Barnes, American Industrial Hygiene Association, Westinghouse Electric Corporation; and J. G. Terrill, Jr., U. S. Public Health Service and American Public Health Association, Division of Sanitary Service, U. S. Public Health Service.

Nineteen nations are participating members of ISO/TC85. They are: Austria, Bulgaria, Finland, France, Germany, Israel, Italy, Japan, Czechoslovakia, Netherlands, Poland, Spain, Sweden, Turkey, United Kingdom, United States, U.S.S.R., Yugoslavia, Hungary.

Seven international organizations were also represented at the meeting: United Nations General Secretariat, United Nations Educational, Scientific, and Cultural Organization, International Labor Organization, World Health Organization, The International Commission on Radiological Units, International Commission on Radiological Protection, and the International Electrotechnical Commission.

The next meeting of the technical committee will be held June, 1958, during the ISO meetings at Harrogate, England.

Coming Meetings

Titanium

The third annual titanium lecture program of New York University's College of Engineering will be held September 9–13. American and foreign authorities from industry and research laboratories will present the lectures at the University Heights campus.

Attendance at the program is limited. Applications and further information may be obtained by writing to Dr. Harold Margolin, New York University, University Heights 53, New York City.

Electronics Conference

The 1957 National Electronics Conference—the 13th annual forum on electronic research, development, and application—will be held at the Hotel Sherman, Chicago, Ill., Oct. 7–9.

Sponsors of the conference are the Illinois Institute of Technology, American Institute of Electrical Engineers, Institute of Radio Engineers, and Northwestern and Illinois universities.

The co-operating institutions are Purdue, Michigan State, Michigan, Notre Dame, and Wisconsin universities, Radio-Electronics-Television Manufacturers Association, and Society of Motion Picture and Television Engineers.

Plant Layout Technical Workshop

The fifth semi-annual session of the Plant Layout Technical Workshop will be held at the Greater Pittsburgh Airport Hotel, Pittsburgh, Pa., Oct. 14–18.

Regular technical lecture periods are planned for each morning of the conference. In addition, each registrant will receive a complete 5000-sq ft layout of the plant area he wishes to study. To register write Homer H. Dasey, Plant Layout Technical Workshop, Box 233, Oakmont (Allegheny County), Pa.

Meetings of Other Societies

Sept. 7–13
Instrument Society of America, twelfth annual conference and exhibit, Cleveland Auditorium, Fenn College, and Hotel Cleveland, Cleveland, Ohio.

Sept. 16–20
Forum Trade Fair of the Atomic Industry, Coliseum, New York, N. Y.

Sept. 16–21
American Society for Testing Materials, Pacific Area national meeting and exhibit, Hotel Statler, Los Angeles, Calif.

Sept. 18
American Society for Metals, annual meeting, Palmer House, Chicago, Ill.

Sept. 22–23
German Association of Architects and Engineers, general assembly, Berlin, Germany.

Sept. 23–25
Standards Engineers Society, annual meeting, Hotel Commodore, New York, N. Y.

Sept. 23–26
Technical Association of the Pulp and Paper Industry, twelfth conference, Netherland-Hilton Hotel, Cincinnati, Ohio.

Sept. 27–28
Institute of Radio Engineers, fall symposium on broadcast transmission systems, Willard Hotel, Washington, D. C.

Oct. 1–3
Institution of Mechanical Engineers, conference on lubrication and wear, London, England.

Oct. 6–8
Fluids Control Institute, Westchester Country Club, Rye, N. Y.

Oct. 9–11
Committee on Vacuum Techniques, fourth national symposium, Hotel Somerset, Boston, Mass.

(For ASME Coming Events, see page 901)

ASME News

With Notes on Society Activities and Events

E. S. Newman, *News Editor*

Canada's famous Chateau Frontenac situated high on a promontory overlooking the St. Lawrence River in Quebec City, will be the meeting place for the 20th annual ASME-AIME Joint Solid Fuels Conference on October 10 and 11

20th Annual ASME-AIME Joint Solid Fuels Conference to Be Held in Quebec With CIM Co-operation October 10-11

First meeting outside United States in picturesque and quaint setting

The annual Joint Solid Fuels Conference has been held in many places since its inception in 1937 by the American Institute of Mining, Metallurgical, and Petroleum Engineers and The American Society of Mechanical Engineers but, for the first time, it will be held in Canada on the invitation of the Coal Division of the Canadian Institute of Mining and Metallurgy.

The famous Chateau Frontenac, high on a promontory overlooking the St. Lawrence River, in picturesque Quebec City, has been selected as the meeting place on Oct. 10 and 11, 1957. The effect of the St. Lawrence Seaway on coal marketing in North America will be one of the major themes of the conference.

The two-day event will include authoritative papers by American and Canadian engineers, industrialists, educators, and public officials. The programs have been arranged by the Coal Divisions of the three organizations. There will be four technical sessions. The first will be devoted to papers under the auspices of CIM and the others under sponsorship of AIME and ASME.

In this fascinating city one can stroll along steep narrow streets and savour the charm of an 18th century French-Provincial town. Amidst an Old World background, however, there are all the comforts and conveniences of modern times. The strong tourist attraction alone is expected to draw a large attendance.

The technical and entertainment programs have been given an added appeal

ASME Papers By Mail

ONLY numbered ASME papers in this program are available in separate copy form until Aug. 1, 1958. Copies can be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Prices are 25 cents each to members of ASME; 50 cents each to nonmembers. Papers must be ordered by the paper numbers listed in this program otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the Conference.

AIME Papers. AIME Joint Solid Fuels Conference papers submitted for publication will be considered for the Mining Transactions Section and the Features Section of Mining Engineering and as accepted will be published accordingly in *Mining Engineering*.

CIM Papers. CIM papers submitted for publication will be considered for the Canadian Mining and Metallurgical Bulletin. For separate copies write to CIM headquarters, 906 Drummond Building, 1117 St. Catherine Street, W., Montreal 2, Canada.

and no one with an interest in solid fuels should miss the conference.

A special invitation is extended to the women for whom an interesting program has been arranged.

The tentative program follows:

▶Thursday, October 10

8:30 a.m. Foyer near Ballroom—Mezzanine Floor
Registration

9:30 a.m. Ballroom—Mezzanine Floor
Technical Session (I)

Co-Chairmen: *C. Gerow*, secretary treasurer, Canadian Institute of Mining and Metallurgy, Montreal, Que., and *A. Ignatieff*, Department of Mines and Technical Surveys, Ottawa, Ont.

Coal, A Source of Canadian Energy, by *C. L. O'Brian*, Dominion Coal Board, Ottawa, Ont.

The Influence of the St. Lawrence Seaway on Marketing of Coal, by *J. R. Frith*, The M. A. Hanna Co., Cleveland, Ohio

Canadian Consumption of Industrial Coals, by *G. McL. Hutt*, Canadian Pacific Railway Co., Montreal, Que., and *E. Swartsman*, Department of Mines and Technical Surveys, Ottawa, Ont.

Limitations Imposed on Coal Used in Central Canada, *George P. Cooper, William J. Moros*, The M. A. Hanna Co., Toronto, Ont.

The Canadian Power Situation With Particular Reference to Thermal Electric Power, by *C. E. Baltser*, Department of Mines and Technical Surveys, Ottawa, Ont.

12:00 Noon Champlain Room
Aperitif

12:30 p.m. River-View Dining Room
Business Luncheon

Presiding: *A. O. Dufresne*, Deputy Minister, Department of Mines, Province of Quebec, Quebec City

Speaker: *C. Ouellet*, Dean of the Faculty of Science, Laval University, Quebec City

2:00 p.m. Ballroom—Mezzanine Floor
Technical Session (II)

Co-Chairmen: *G. L. Judy*, Consolidation Coal Co., Fairmont, W. Va., and *J. B. Morrow*, coal consultant, Pittsburgh, Pa.

Evolution and Growth of Continuous Coal Mining Systems, by *P. R. Paulick*, Bethel Park, Pa.

Dust Control for Mechanized Underground Mining Operations, by *Donald Wiebe*, Joy Manufacturing Co., Saltsburg, Pa.

Flow of Coal in Bins, by *F. D. Cooper* and *J. R. Garvey*, Bituminous Coal Research Inc., Columbus, Ohio (Paper No. 57—FU-2)

4:00 p.m. Salon 1—Mezzanine Floor
Executive Committee
Fuels Division, ASME

Salon 2—Mezzanine Floor
Executive Committee
Coal Division, AIME

5:00 p.m. Salon 2—Mezzanine Floor
Joint Conference Committee Meeting

6:00 p.m. Champlain Room
Social Hour

7:00 p.m. Ballroom—Mezzanine Floor
Banquet

Presiding: *T. S. Spicer*, Pennsylvania State University

Presentation of Percy Nicholls Award for 1957

▶Friday, October 11

8:30 a.m. Foyer near Ballroom—Mezzanine Floor
Registration

9:15 a.m. Ballroom—Mezzanine Floor
Technical Session (III)

Co-Chairmen: *J. C. McCabe*, Combustion Publishing Co., New York, N. Y., and *J. M. Pilcher*, Battelle Memorial Institute, Columbus, Ohio

The Eighth Sea, a color, documentary film of the St. Lawrence Seaway and Power Project, by *E. V. Tidman*, Hewitt Equipment Ltd., Montreal, Que.

Pelletizing of Fine Coals, by *M. P. Corriveau*, Clinchfield Coal Co., Dante, Va., and *Thomas Linton*, Link-Belt Co., Chicago, Ill.

Thermal Stabilization of Anthracite by Calcination,[1] by *J. W. Eckerd* and *R. F. Tenney*, U. S. Bureau of Mines, Schuylkill Haven, Pa.

Problems of Freezproofing North Dakota Lignite, by *R. C. Ellman* and *J. W. Belter*, U. S. Bureau of Mines, Grand Forks, N. Dak.

12:00 Noon Champlain Room
Aperitif

12:30 p.m. River-View Dining Room
Informal Luncheon

2:00 p.m. Ballroom—Mezzanine Floor
Technical Session (IV)

Co-Chairmen: *E. F. Osborn*, Pennsylvania State University, and *T. R. Scollon*, U. S. Bureau of Mines, Washington, D. C.

Use Value of Competitive Fuels, by *V. C. Smith*, Management Group Companies, Charleston, W. Va.

Sound Methods of Solid Fuel Evaluation for Use in Thermal Power Stations, by *E. D. Holdup*, The Hydro-Electric Power Commission of Ontario, Toronto, Ont. (Paper No. 57—FU-1)

The Use of Gravity Methods for Cleaning the Extremely Fine Sizes of Bituminous Coal, by *D. R. Mitchell* and *H. B. Charmbury*, Pennsylvania State University

Women's Program

Thursday, October 10

9:00 a.m. Registration
Foyer near Ballroom—Mezzanine Floor
10:00 a.m. Coffee and Entertainment (Complimentary) Champlain Room
12:30 p.m. Bus to Lac Beauport
1:00 p.m. Luncheon at Manoir Saint Costin
2:30 p.m. Bus leaves Lac Beauport for scenic tour of Quebec City, and return to hotel by 4:00 p.m.
6:00 p.m. Social Hour Champlain Room
7:00 p.m. Banquet and Entertainment Ballroom—Mezzanine Floor

Friday, October 11

9:30 a.m. Scenic bus tour to Ste. Anne de Beaupre
1:00 p.m. Luncheon at the Cercle Universitaire, or Kerhulu
4:00 p.m. Tea at the Citadelle (Complimentary)

Authors' Breakfasts

The Authors' breakfasts will be held at 8:00 a.m. on October 10 and 11, in Salon 4, Mezzanine Floor

[1] Paper not available—see box on this page.

ASME-ASLE to Meet at Lubrication Conference in Toronto, Canada

Royal York Hotel, Oct. 7–9, 1957

THE Lubrication Division of The American Society of Mechanical Engineers and The American Society of Lubrication Engineers will meet at the fourth joint lubrication conference on Oct. 7–9, 1957, at the Royal York Hotel, Toronto, Ont., Canada. Features of the conference will be studies on wear, contact fatigue, high-temperature lubrication, and high lights of The Institution of Mechanical Engineers Conference which will be held October 1–3 in London, England.

This conference which has been growing steadily in scope is expected to attract many lubrication engineers from the United States, Canada, and abroad. More than 400 engineers attended last year's meeting.

▶Monday, October 7

9:30 a.m.
Session 1—Recent Experiments in Wear

Chairman: *A. C. West*, California Research Corp., Richmond, Calif.

Wear o Cobalt Base and Stainless Materials in High Purity Water, by *N. B. Dewees, B. Levy*, and *I. A. Marsh*, Westinghouse Atomic Power Division, Pittsburgh, Pa. (ASLE Paper No. 57—LC-1)

A Study of the Effect of Wear Particles and Adhesive Wear at High-Contact Pressure, by *E. B. Sciulli* and *G. M. Robinson*, Franklin Institute, Philadelphia, Pa. (ASLE Paper No. 57—LC-2)

Orders for Lubrication Conference Papers

ONLY copies of *numbered* papers will be available. Some of the papers may not be available in time for you to receive them in advance of the Conference.

ASME Papers. Copies of ASME papers may be obtained by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 25 cents each to members and 50 cents each to nonmembers. Only *numbered* papers are available in pamphlet form. Please order only by paper *number*, otherwise the order will be returned.

ASLE Papers. Copies of ASLE papers may be ordered by writing to ASLE, 84 East Randolph Street, Chicago, Ill. Papers are priced at 35 cents each to members and 50 cents each to nonmembers. Only the *numbered* papers are available in pamphlet form. Please order by paper *number* only.

Call for Agenda Items for 1958 RAC Meetings

THE 1958 Agenda Committee extends an invitation to every member of ASME to offer suggestions and improvements in the operations of the Society. This invitation is a step in the democratic process by which the membership and the Sections impart their ideas to the Council.

Please word your proposed items so that they are clear and specific and so that there will be no misunderstanding as to intent. Also, be sure the wording is positive so that action can be taken either to "approve" or "reject" the item as worded. Accompany each item with a short statement as to why you feel the item should be approved.

All agenda items are to be submitted in accordance with the following form, *and should be sent to the Secretary of your Section not later than October 1, 1957*. The Agenda Committee of each Section will screen these items against items previously considered by the Council, and forward the items to the National Agenda Committee not later than November 1, 1957.

If you lack the address of your Section Secretary, you may send your items, *not later than October 1, to the ASME Agenda Committee, 29 West 39th Street, New York 18, N. Y.*

ASME Agenda Item

PROPOSED BY ..... of the ..... Section

Address .....

Date .....

Item: It is proposed that

Proposer's Comment:

.....
Signature

Chrome Face vs. Iron Side Wear—An Analysis of Some Radioactive Piston-Ring Wear Studies, by *R. G. Abowd, Jr.*, Ethyl Corp., Detroit, Mich. (ASLE Paper No. 57—LC-3)

The Role of Atmospheric Oxidation in High-Speed Sliding Phenomena, Part 2, by *M. Cocks*, Ford Motor Co., Dearborn, Mich. (ASLE Paper No. 57—LC-4)

2:00 p.m.

Session 2—Boundary Lubrication

● Conference high lights of IMechE Program—Boundary-Lubrication Papers

A Theory of Cutting-Tool Wear and Cutting-Oil Action, by *A. Dorinson*, Sinclair Research Laboratories, Harvey, Ill. (ASLE Paper No. 57—LC-5)

Boundary Lubrication, Wear-In, and Hydrodynamic Behavior of Bearings for Liquid Metals and Other Fluids, by *L. F. Coffin, Jr.*, General Electric Research Laboratories, Schenectady, N. Y. (ASLE Paper No. 57—LC-6)

▶Tuesday, October 8

9:00 a.m.

Section 3—High Temperature Lubrication

Chairman: *A. Hundere*, Southwest Research Institute, San Antonio, Tex.

A Review of Current Development Problems in High-Speed, High-Temperature Aircraft Bearings,[1] by *C. C. Moore*, General Electric Co., Evendale, Ohio, and *P. Lewis*, General Electric Co., Schenectady, N. Y. (ASME Paper)

On Friction and Lubrication at Temperature to 1000 F With Particular Reference to Graphite, by *E. E. Bisson, R. L. Johnson* and *W. J. Anderson*, NACA, Lewis Flight Propulsion Laboratories, Cleveland, Ohio (ASME Paper No. 57—LUB-1)

Solid Film Lubricants at High Temperatures, by *E. P. Kingsbury*, Massachusetts Institute of Technology, Cambridge, Mass. (ASLE Paper No. 57—LC-7)

2:00 p.m.

Session 4—Factors Affecting Contact Fatigue

Chairman: *E. G. Jackson*, General Electric Co., West Lynn, Mass.

Investigation of Factors Governing Fatigue Life With the Rolling Contact Fatigue Spin Rig, by *T. L. Carter, R. H. Butler, H. R. Bear* and *W. J. Anderson*, NACA, Lewis Flight Propulsion Laboratories, Cleveland, Ohio (ASLE Paper No. 57—LC-8)

The Effect of Aircraft Gas-Turbine Oils on Roller-Bearing Life, by *M. E. Otterbein*, Hyatt Roller Bearing Div., General Motors Corp., Harrison, N. J. (ASLE Paper No. 57—LC-9)

The Effect of Lubricants on Gear-Tooth Fatigue, by *T. F. Davidson*, Wright Air Development Center, and *P. M. Ku*, Southwest Research Institute, San Antonio, Texas (ASLE Paper No. 57—LC-10)

▶Wednesday, October 9

9:00 a.m.

Session 5—Fluid Film Lubricated Bearings

Chairman: *E. A. Allcut*, University of Toronto, Toronto, Ont., Canada

● Conference high lights of the IMechE Conference—Fluid Film Lubrication

A Solution for the Finite Journal Bearing and its Application to Analyses and Design—Part 3, by *A. A. Raimondi* and *J. Boyd*, Westinghouse Research Laboratories, Pittsburgh, Pa. (ASME Paper)

Self-Excited Vibration of an Air-Lubricated Thrust Bearing,[1] by *L. Licht, D. D. Fuller*, and *B. Sternlicht*, General Electric Co., Schenectady, N. Y. (ASME Paper)

2:00 p.m.

Session 6—Recent Studies of Fluid Film Lubrication

Chairman: *F. R. Archibald*, Arthur D. Little Co., Cambridge, Mass.

Behavior of Lubrication-Film Side Leakage in Dynamically-Loaded Bearings,[1] by *M. N. Ondas*, M.I.T., Cambridge, Mass. (ASME Paper)

The Determination of Flow, Film Thickness, and Load-Carrying Capacity of Hydrostatic Bearings Through the Use of the Electric-Analog Field Plotter, by *A. M. Loeb*, Franklin Institute, Philadelphia, Pa. (ASLE Paper No. 57—LC-11)

Surface Deformations in the Hydrodynamic Slider Bearing Problem and Their Effect on the Pressure Development,[1] by *J. F. Osterle* and *E. Saibel*, Carnegie Institute of Technology, Pittsburgh, Pa. (ASME Paper)

[1] Paper not available—see box on this page.

[1] Paper not available—see box on this page.

[1] Paper not available—see box on this page.

ASME Coming Events

Sept. 22–25

ASME Petroleum Mechanical-Engineering Conference, Hotel Mayo, Tulsa, Okla.

Sept. 23–25

ASME Fall Meeting, Hotel Statler, Hartford, Conn.

Oct. 7–9

ASLE-ASME Lubricating Conference, concurrently with ASME-IMechE International Conference on Lubrication and Wear, Royal York Hotel, Toronto, Ont., Canada

Oct. 10–12

ASME-AIME Fuels Conference, Chateau Frontenac, Quebec, Que., Can.

(*Continued on next page*)

(*Continued from page 901*)

Oct. 21–23

ASME Power Conference, Americus Hotel, Allentown, Pa.

Dec. 1–6

ASME Annual Meeting, Hotel Statler, New York, N. Y.

March 2–6, 1958

ASME Gas Turbine Power Conference and Exhibit, Shoreham Hotel, Washington, D. C.

March 16–22, 1958

Nuclear Congress, International Amphitheater, Chicago, Ill. (ASME is co-sponsor.)

March 17–20, 1958

ASME Aviation Conference, Hotel Statler-Hilton, Dallas, Tex.

March 19–20, 1958

ASME Engineering Management Conference, Somerset Hotel, Boston, Mass.

April 1–3, 1958

ASME Instruments and Regulators Conference, University of Delaware, Newark, Del.

April 9–10, 1958

ASME Railroad Conference, Hotel Statler, Cleveland, Ohio

April 14–15, 1958

ASME Plant Maintenance Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

April 14–17, 1958

ASME Design Engineering Conference, International Amphitheater, Chicago, Ill.

April 15–17, 1958

ASME-AWS Metals Engineering Division, joint conference, Hotel Statler, St. Louis, Mo.

April 24–25, 1958

ASME Management-SAM Conference, Hotel Statler, New York, N. Y.

May 18–22, 1958

ASME Oil and Gas Power Conference and Exhibit, Bellevue-Stratford Hotel, Philadelphia, Pa.

May 22–23, 1958

ASME Wood Industries Conference, Syracuse University, Syracuse, N. Y.

June 11–14, 1958

Third U. S. Congress of Theoretical and Applied Mechanics, Brown University, Providence, R. I. (ASME is co-sponsor.)

June 15–19, 1958

ASME Semi-Annual Meeting, Hotel Statler, Detroit, Mich.

Note: Members wishing to prepare a paper for presentation at ASME national meetings or divisional conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y., for which there is no charge providing you state that you are a member of ASME.

(*For Meetings of Other Societies, see page 898*)

The General Arrangements Committee for the first national ASME Power Conference to be held outside of New York City, October 21–23, at the Americus Hotel, is shown at a planning meeting held in the Pennsylvania Power and Light Company building in Allentown, Pa. The committee members shown in the photo are, sitting, *left to right,* C. E. Lewis, chairman, Plant Trips; E. W. Nelson, chairman, Finance; C. C. Curley, chairman, Reception; Ray E. Roushey, chairman; M. D. Engle, chairman, Technical Events; Roscoe Meadows, Power Division Sponsor; J. G. Miller, Technical Events Committee. Standing, *left to right,* D. R. Rees, chairman, Publicity; G. F. Bierman, Printing and Signs; K. K. Feridun; J. H. Fernandes, chairman, Information and Registration Committee; J. R. Connelly, Hotel Committee; Bill McLean, chairman, Ladies Committee; R. L. Hallman, chairman, Entertainment; R. H. Swoyer, chairman, Hotel.

ASME Power Conference to Be Held at Americus Hotel, Oct. 21–23, 1957, Allentown, Pa.

Technical papers to cover many topics including nuclear power developments

THE first national Power Conference of The American Society of Mechanical Engineers to be held outside New York City offers many significant papers in the power field.

The conference will be presented in Allentown, Pa., October 21–23, at the Americus Hotel. The Anthracite-Lehigh Valley Section is host.

In addition to technical papers including industrial power and cooling tower developments, controlled starting of high-pressure turbines, a new type of combustion control, there will be papers on nuclear power developments. Inspection trips, a program for women, and a number of social events are scheduled.

The tentative program follows:

▶Monday, October 21

8:00 a.m.

Registration

9:30 a.m.

Session 1—Industrial Power and Cooling Tower Applications

Chairman: *Roscoe Meadows, Jr.*, Newport News Shipbuilding and Dry Dock Co., Newport News, Va.

Vice-Chairman: *F. G. Feeley, Jr.*, Olin Mathieson Corp., New York, N. Y.

Design Considerations in the Development of a Cyclone-Fired Boiler Installation for Kodak Park, by *R. L. Young*, Eastman Kodak Co., Rochester, N. Y. (Paper No. 57—PWR-1)

Selection and Application of Cooling Towers in Steam-Electric Stations, by *E. E. Goitein*, Foster Wheeler Corp., San Mateo, Calif. (Paper No. 57—PWR-5)

2:00 p.m.

Session 2—Portland Station

Chairman: *Arthur T. Hunter*, Combustion Engineering Corp., New York, N. Y.

Vice-Chairman: *G. Elmer Klapper*, Philadelphia Electric Co., Philadelphia, Pa.

Axial-Flow Exhaust Turbine and Monotube Boiler Are Basic Design Considerations of Portland Generating Station, by *J. G. Miller*, Metropolitan Edison Co., Reading, Pa. and *R. H. Kreissinger* (Paper No. 57—PWR-3).

Design Features and Development of the Cross-Compound Single-Flow Turbine With Axial Exhaust Hood, by *J. E. Fowler*, General Electric Co., Schenectady, N. Y., and *C. Matney* (Paper No. 57—PWR-6)

The Condenser at Portland,[1] by *G. T. Jones*, Ingersoll-Rand Co., New York, N. Y.

Unusual Features of the Portland Combustion-Control System,[1] by *E. D. Scutt*, Leeds & Northrup Co., Philadelphia, Pa.

▶Tuesday, October 22

8:00 a.m.

Registration

9:00 a.m.

Session 3—Martins Creek Plant

Chairman: *Paul Gourdon*, Ebasco Services Inc., New York, N. Y.

[1] Paper not available—see box on page 903.

Availability of Papers

ONLY numbered ASME papers in this program are available in separate copy form until Aug. 1, 1958. Copies can be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Prices are 25 cents each to members of ASME; 50 cents each to nonmembers. Papers must be ordered by the paper numbers listed in this program otherwise the order will be returned. The final listing of available technical papers will be found in the issue of MECHANICAL ENGINEERING containing an account of the Conference.

Vice-Chairman: *H. C. Schweikart*, Gilbert Associates, Inc., Reading, Pa.

The Martins Creek Steam-Electric Station New Ideas to Reduce the Cost of Construction and of Operation, by *M. D. Engle*, Pennsylvania Power and Light Co., Allentown, Pa. (Paper No. 57—PWR-2)

Controlled Starting and Loading of Modern Central Power Stations, by *F. W. Kuehn*, Pennsylvania Power and Light Co., Hazleton, Pa. (Paper No. 57—PWR-7)

Effect of Heated Condenser Discharge Water Upon Aquatic Life, by *R. Van Vliet*, Pennsylvania Power and Light Co., Allentown, Pa. (Paper No. 57—PWR-4)

▶Wednesday, October 23

8:00 a.m.

Registration

9:00 a.m.

Session 4—Turbine and Generator Rotors

Chairman: *Charles D. Wilson*, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Vice-Chairman: *V. F. Estcourt*, Pacific Gas and Electric Co., San Francisco, Calif.

Investigation of the Generator-Rotor Burst at the Pittsburg Station of the Pacific Gas and Electric Company,[1] by *D. R. DeForest, L. P. Grobel*, and *B. R. Seguin*, General Electric Co., Schenectady, N. Y.

Ultrasonic Detection of Thin Laminar Inclusions,[1] by *S. Serabian, G. H. Boss*, and *C. D. Moriarty*, General Electric Co., Schenectady, N. Y.

Operating Experiences With High-Temperature Steam-Turbine Rotors and Design Improvements in Rotor-Blade Fastenings,[1] by *N. L. Mochel* and *J. D. Conrad*

2:00 p.m.

Session 5—Nuclear Power

Chairman: *H. F. Hatfield*, Pennsylvania Power and Light Co., Pittsburgh, Pa.

Vice-Chairman: *R. W. Hartwell*, Detroit Edison Co., Detroit, Mich.

Nuclear Power Trends,[1] by *W. T. Moore*, The Babcock and Wilcox Co., New York, N. Y.

Pennsylvania Advanced Reactor,[1] by *S. C. Townsend* and *M. Johnson*, Pennsylvania Power & Light Co., Allentown, Pa.

[1] Paper not available—see box on this page

The Role of Digital Computers in Automatic Control, by *Marc Pélégrin*, Ministère de la Défense Nationale et des Forces Armées, Paris, France, and *F. H. Raymond*, Société d'Electronique et d'Automatisme, Courbevois (Seine), France

Some Problems on the Theory of Discrete Automatic Systems, by *J. Z. Tsypkin*, The Institute of Automatics and Telemechanics, The Academy of Science, Moscow, U.S.S.R.

Dynamic Programming and the Computational Solution of Feedback Control Design Problems, by *R. Bellman*, The Rand Corp., Santa Monica, Calif.

Analog-Digital Conversion Techniques, by *A. K. Susskind*, M.I.T., Servomechanisms Laboratory

6:00 p.m.

Cocktail Hour

7:00 p.m.

Banquet

▶Thursday, October 17

Session 2—Computers in Control System Design I

9:30 a.m.

Chairman: *E. L. Harder*, Westinghouse Electric Corp., East Pittsburgh, Pa.

Introduction: Session Chairman

A Computer Combining Analog and Digital Principles for Complex Frequency Network Calculations, by *P. F. Blackman*, Imperial College of Science and Technology, London, England

Computer Verification of Steam Generator Instrumentation for a Nuclear Power Plant, by *D. P. Watte* and *E. E. Lynch*, General Electric Co., West Lynn, Mass.

Analog Representation of Heat Exchange. Application to the Simulation of Heat Exchangers of Nuclear Power Plants, by *J. M. Casteron* and *G. Delaux*, Electricité de France, Paris, France

Evaluation of a Turbojet Control on an Engine Simulator, by *C. R. Hessing*, General Electric Co., Cincinnati, Ohio

A Simulation Technique in the Synthesis of Automatic Flight Control Systems, by *Y. Nakada* and *S. I. Scroggs*, Hughes Aircraft Co., Culver City, Calif.

Differential Analyzer Aids Design of Computer Control System for Electric Utilities, by *I. K. Kirchmayer*, General Electric Co., Schenectady, N. Y.

Session 3—Sampled-Data Systems

Chairman: *J. R. Ragazzini*, Columbia University

Introduction: Session Chairman

The Analysis of Digital Systems, by *H. A. Helm*, Bell Telephone Laboratories, Whippany, N. J.

Signal Flow Techniques for Digital Compensation, by *J. M. Salzer*, The Magnavox Research Labs., Los Angeles, Calif.

Analog Computer Study of Sampled Data Systems, by *H. Chestnut* and *D. W. Leiby*, General Electric Co., Schenectady, N. Y.

The Synthesis of Computer Limited Sampled Data Control Systems, by *A. N. Robinson*, Eclipse-Pioneer Division of Bendix Aviation, Teterboro, N. J.

Rate Limiting in Incremental Computers, by *M. H. Steward*, The Magnavox Research Labs., Los Angeles, Calif.

Session 4—Computers in Control Systems

Chairman: *E. M. Grabbe*, The Ramo-Wooldridge Corp., Los Angeles, Calif.

Introduction: Session Chairman

Real Time Hybrid Computers for Control Systems, by *C. T. Leondes*, University of California, Los Angeles

Computer Control Experience Gained From Operation of a Large Combined Analog Digital Computation System, by *G. P. West*, The Ramo-Wooldridge Corp., Los Angeles, Calif.

Compensation of Nonlinear and Time-Varying Systems by Computers, by *R. Boanton* and *A. Rosenbloom*, M.I.T., and The Ramo-Wooldridge Corp., Los Angeles, Calif.

Analysis of an On-Off Digital Control System, by *J. S. Mayo*, Bell Telephone Laboratories, Whippany, N. J.

The Design of a Digital Computer for an Airborne Control System, by *J. T. Caulfield, J. V. B. Cooper, W. R. Maclay*, and *O. B. Shafer*, I.B.M., Poughkeepsie, N. Y.

Reduction of Control Loop Errors With a Prediction Computer, by *George Axelby* and *R. H. Plath*, Westinghouse Air Arm Division, Baltimore, Md.

ASME to Participate With AIEE and IRE in Meeting on Computers in Control

THE AIEE Feedback Control Systems Committee with participation by the IRE Professional Group on Automatic Control and the ASME Instruments and Regulator Division is organizing a symposium on the theme of "Computers in Control" at the Chalfonte-Haddon Hall Hotel in Atlantic City, N. J., on Oct. 16–18, 1957. The symposium will emphasize the use of digital and analog computers both as elements of feedback control systems and as utilized in the design of such systems.

Some 35 technical papers by leading scientists in this country and by Prof. J. Tsypkin of The Academy of Science, Moscow, U.S.S.R.; Dr. M. Pélégrin of The Ministry of Defense, France; and Dr. Blackman of The Imperial College of Science and Technology, London, England, will be presented.

The opening session Wednesday afternoon will be followed by a banquet Wednesday evening. Technical sessions on October 17 will culminate in a panel discussion Thursday evening on the topic, "Fitting Computers Into Control Systems," with Harold Chestnut as moderator and including participation by Eugene Grabbe of Ramo-Wooldridge, E. James of du Pont, John Moore of Autonetics Division of North American, J. F. Rientjes of M.I.T., E. L. Harder of Westinghouse, H. T. Marcy of I.B.M., and J. R. Ragazzini of Columbia University. Friday morning will be devoted to the closing technical sessions.

A portion of the papers to be presented at the conference are available in preprint form from the AIEE: the Proceedings of the Conference will be published by the AIEE during the first part of 1958. Conference arrangements have been made by a committee consisting of several leaders in the field.

Anyone interested in attending this meeting may obtain reservation forms and a complete advance program by writing to the ASME Meetings and Divisions Manager, 29 West 39th Street, New York 18, N. Y.

The technical program follows:

▶Wednesday, October 16

Introductory Session

2:00 p.m.

Chairman: *J. G. Truxal*, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

Welcoming Remarks: *Harold Chestnut*, General Electric Co., Schenectady, N. Y.

Introduction: Session Chairman

Session 5—Computers in Control System Design 2

2:00 p.m.

Chairman: *H. T. Marcy*, IBM Corp., New York, N. Y.

Introduction: Session Chairman

System Considerations in Computer Control of a Semi-Continuous Chemical Process, by *T. M. Stout*, The Ramo-Wooldridge Corp., Los Angeles, California.

Airborne Program Computer, by *C. F. Coit* and *T. F. Mahoney*, Raytheon Manufacturing Co., Wayland, Mass.

General Synthesis Procedure for Computer Control of Single and Multiloop Linear Systems, by *R. E. Kalman* and *J. E. Bertram*, Columbia University

An Application of Root Locus Analysis to a Closed Loop Linear Control System Incorporating a Human Operator, by *J. Rodden* and *J. E. Mangelsdorf*, Lockheed Aircraft Corp., Sunnyvale, Calif.

The Solution of Differential Equations in the Time Domain, by *C. W. Steeg*, RCA, Waltham, Mass. and *R. V. Morris*, M.I.T.

Session 6—Panel Discussion: Fitting Computers Into Control Systems

7:30 p.m.

E. M. Grabbe, Ramo-Wooldridge, Computer Systems Division, Los Angeles, Calif.

E. L. Harder, Westinghouse, Analytical Engineering, East Pittsburgh, Pa.

E. W. James, E. I. du Pont, Newark, Del.

H. T. Marcy, IBM Corp., Poughkeepsie, N. Y.

J. R. Moore, North American Aviation Autonetics, Downey, Calif.

J. R. Ragazzini, Columbia University, Electrical Engineering Department

J. F. Rienjes, M.I.T., Servo Laboratory

Moderator: *H. Chestnut*, General Electric, General Engineering Laboratory, Schenectady, N. Y.

▶Friday, October 18

Session 7—Optimum Systems

9:30 a.m.

Chairman: *Rufus Oldenburger*, Purdue University, Lafayette, Indiana

Introduction: Session Chairman

Control System Optimization Using Computers as Control System Elements, by *L. F. Kazda*, University of Michigan

A Dual-Mode Servomechanism Utilizing Saturation Switching, by *H. R. Weed* and *F. C. Weimer*, The Ohio State University

Optimum Response of Discontinuous Feedback Control Systems, by *F. W. Nesline, Jr.*, M.I.T.

Divided Reset Compensation of a Nonlinear Control System, by *J. W. McCarthy*, M.I.T.

Application of a Self-Adaptive System to the Control of Airplane Normal Acceleration, by *M. F. Marx*, General Electric Co., Schenectady, N. Y.

Closing Remarks: *Harold Chestnut*, General Electric Co., Schenectady, N. Y.

Curt Keller Receives ASME GTP Award in Zurich

Curt Keller, Mem. ASME since 1949, received an award from the Gas Turbine Power Division of The American Society of Mechanical Engineers in recognition of his—and his colleagues'—pioneering at the Escher-Wyss Engineering Works. On June 22, in Zurich, Switzerland, the GTP award was presented for their perseverance in research, design, and development which led to the construction and operation of the first closed-cycle gas-turbine power plant.

The honor, the twelfth given by the Division, originally was presented by ASME President W. F. Ryan during the GTP Conference in Detroit, Mich., March 18–21, 1957. In Dr. Keller's absence, R. Tom Sawyer, former chairman of the Division, received the award on Dr. Keller's behalf. In making the presentation, Dr. Ryan announced that Mr. Sawyer would take the award to Dr. Keller when he attended an engineering meeting at Zurich, the week of June 17.

Mr. Sawyer made the formal presentation of the award at a special dinner at Zurich's Dolder Grand Hotel, the evening of June 22. Among those present were Dr. Keller's wife and daughter; also Jacob Ackeret, Hon. Mem. ASME, and co-inventor of the closed-cycle gas turbine; and Dr. and Mrs. Curt F. Kollbrunner, he representing the Swiss Society of Engineers and Architects.

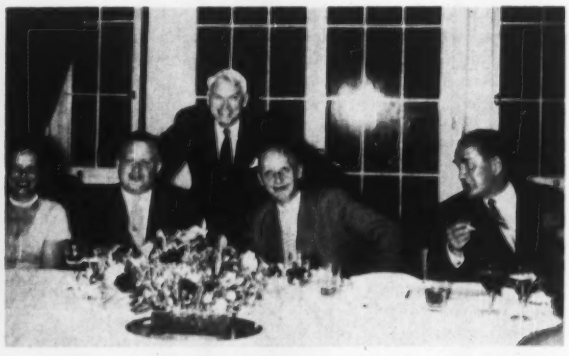
Americans present, beside Mr. Sawyer and his wife and two daughters, were R. L. Stanley, of the Diesel Engine Manufacturers Association, Chicago, Ill., G. W. Ferguson, of the Texaco Research Center, Beacon, N. Y., E. G. Beardsley, a vice-president of Clark Brothers, Olean, N. Y., and T. A. LaBrecque, president of the Hilliard Corporation, Elmira, N. Y., and his wife. The men are all members of ASME. We are indebted to Mr. LaBrecque and his camera for our pictures of the presentation.

Dr. Keller's firm, Escher-Wyss, has done the basic work in the development of the closed-cycle gas turbine. In this external-combustion engine, the gaseous working medium travels in a closed circuit, receiving its heat input from an outside source through a heat exchanger, and giving up its rejected heat to another outside medium through other heat exchangers. It resembles a steam-power plant, except in its use of a compressor unit, and the fact that the working medium does not liquefy at any part of the cycle.

Among its advantages are higher pressures than those feasible for the open cycle; hence, flow passages can be made smaller for a given weight and velocity of flow.

Mr. Sawyer, a consulting engineer of Ho-Ho-Kus, N. J., who took the award to Zurich, was the first chairman of the Gas Turbine Power Division. GTP became an ASME Division in 1947.

At the Dolder Grand Hotel in Zurich, June 22, Dr. Curt Keller, *left*, receives from R. Tom Sawyer the GTP Award testifying to his great service in research, design, and development leading to the first closed-cycle gas turbine, a principle which now finds application in nuclear power plants. *Seated* are Mrs. Sawyer and Dr. Kollbrunner of the Swiss Society of Engineers and Architects.



R. Tom Sawyer, former Chairman of ASME Gas Turbine Power Division, is host in Zurich to Curt Keller, recipient of GTPaward for advancement of the gas-turbine art. Shown, *left to right,* are Mrs. Kollbrunner; Dr. Keller; Mr. Sawyer, *standing;* Dr. Jacob Ackeret, Hon. Mem. ASME, co-inventor of the closed-cycle gas turbine; and Dr. Curt F. Kollbrunner, representing the Swiss Society of Engineers and Architects.

Engineers' Starting Salaries Continue Spiralling Upward

▶The Lehigh Story

MECHANICAL ENGINEERING majors graduating from Lehigh University, Bethlehem, Pa., in June, started work at salaries averaging $465 a month, Everett A. Teal, director of placement and counseling services at Lehigh, reports in an analysis of job placement of the class graduated in June.

The average starting salary this year for mechanical engineers represents a boost of 11 per cent from a year ago when the average starting salary was $420.

Electrical engineers commanded the top starting salary with an average of $488. In second place were engineering physicists with a $481 start, and mechanical engineers were third with $465. Then followed chemical and metallurgical engineers, each starting at $460.

Mr. Teal pointed out that the average starting salary for men in all nine branches of engineering taught at Lehigh is $465—exactly that of mechanical engineers. This also represents an 11 per cent increase. A year ago the average starting salary for all engineers was $418.

His report shows that 732 interviews were held on the Lehigh campus for mechanical-engineering majors by personnel men representing 149 companies.

In his breakdown on 72 mechanical engineers, he said that three have turned down job offers in order to work toward their master's degree. Three others will go into military service.

Members of Lehigh's graduating class were sought by more employers and were offered more jobs with higher starting salaries than a year ago.

But, the type of work was rated as the top factor which influenced job selection by the Lehigh seniors. Mr. Teal reported that 271 listed the type of work as the first choice of the student preference rating in job selection; location of employment was the second factor; and reputation of the company ranked as the third reason in job selection. Those who received diplomas from the College of Arts and Science accepted average offers of $391 compared to $380 a year ago. Business administration majors found the ante raised from $377 in 1956 to $398 this June.

Placement statistics indicate that 5663 interviews were held during the past seven months. From these, there were 415 acceptances of positions with 199 companies throughout the nation.

Of this year's crop of Lehigh graduates, 57 did not seek employment since their plans call for graduate studies. Another 55 are reporting for military service within the next three months. Although they have accepted jobs, another 42 received commissions as second lieutenants in the Army and Air Force and are slated for military service later.

A check at the Lehigh placement center reveals that approximately 400 companies already have requested interviews with next year's seniors during the months of November, December, and January.

Mr. Teal believes that the demand may not be as heavy next year as this, but that the supply will not be sufficient to meet the demand. He predicts that starting salaries may be hiked approximately five per cent next year with an average salary for engineers ranging in the vicinity of $485.

▶IIT Reports on January and June Graduates

JANUARY and June engineering graduates at Illinois Institute of Technology commanded an average $473 per month salary, reported Earl C. Kubicek, director of alumni relations and placement.

"This is $82 more per month than the 1956 average for engineering graduates," he said.

"Salaries have increased every year since 1938, when we began keeping records," he explained. "At that time engineering graduates averaged $100 per month."

Electrical engineers again received the highest salaries—$515 a month, compared with $461 last year.

Other high department averages were: metallurgical engineering, $490; industrial engineering, $484; mechanical engineering, $473; civil engineering, $470, and chemical engineering, $458.

These figures, said Mr. Kubicek, indicate only the immediate demands for certain types of engineering skills over others. All engineering majors have been increasing steadily in starting salaries.

The over-all average, he pointed out, also included starting salaries for fire protection and safety engineering, food engineering, and mechanics.

Figures, based on a 40-hour work week, do not include starting salaries of graduates whose work experience prior to graduation exceeds one year.

Neither are statistics included for graduates who did the major portion of their undergraduate work in the IIT evening division while regularly employed, ROTC students who went immediately into the armed forces, and those continuing for graduate study.

Nearly 1200 interviews with representatives of industry and business were arranged by the IIT placement service. Schedules were arranged for seven companies each day, representing an average of 5.5 interviews per graduate.

The placement service regularly serves some 75 per cent of the graduating seniors.

Starting Salaries for Lehigh Graduates

	1956 Average starting salary	1957 Average starting salary	Amount of increase	Percentage of increase
Arts	$380	$391	$11	3%
Business	$377	$398	$21	6%
ENGINEERING				
Chemical engineering	$410	$460	$50	12%
Chemistry	$421	$434	$13	3%
Civil engineering	$413	$457	$44	11%
Electrical engineering	$426	$488	$62	15%
Engineering physics	$428	$481	$53	13%
Industrial engineering	$407	$453	$46	11%
Mechanical engineering	$420	$465	$45	11%
Metallurgical engineering	$420	$460	$40	10%
Mining engineering	$415	$448	$33	8%
Total engineering	$418	$465	$47	11%

Lehigh University Preference Rating in Job Selection—Class of 1957

	First choice	Second choice	Third choice	Fourth choice
Type of work	271	54	23	23
Location of company	43	95	54	58
Reputation of company	37	92	85	49
Training program	17	55	29	28
Interviewing policies	9	11	29	23
Size of company	8	33	41	53
Salary offered	2	46	100	68
Co. information literature	1	3	6	14
Other reasons	18	7	8	3

ALOHA ASME— ASME group who toured Hawaiian Islands following 1957 Semi-Annual Meeting are shown with guides at an Island stop. W. F. Ryan, ASME President, easily identified in photo, stands to right of Mrs. U. A. Rothermel, President, Woman's Auxiliary to ASME.

Woman's Auxiliary to ASME Reports on Scholarship Funds

▶Report of the Sylvia W. Farny Scholarship Committee

THREE applications out of 21 received were approved by the Scholarship Committee of the Woman's Auxiliary to ASME for the year 1957–1958. The Metropolitan and Detroit Sections each contributed a complete scholarship.

The recipients of these awards are from the Universities of New Mexico, North Dakota, and Kentucky. Each is 20 years of age, unmarried, and will be graduated in June, 1958. They are outstanding young men, from whom professors and observers expect worth-while achievement and potential future leadership in the engineering profession. Their reasons for needing help are sound. The Committee is grateful to the various Sections for their generous contributions to the fund and trust the records of these young men will be an incentive to continued support in the future.

The 1957–1958 Committee includes Mrs. Crosby Field, Metropolitan Section; Mrs. Maurice Weschler, Washington Section; Mrs. William H. Larkin, Metropolitan Section; Mrs. Arthur H. Gompf, Baltimore Section; and Mrs. Ralph L. Goetzenberger, Washington Section, who is chairman.

▶Report of the Calvin Rice Memorial Scholarship Fund

Chile, Iraq, Norway, The Netherlands, and Lebanon were represented in requests for the 1957–1958 Calvin Rice Scholarship. The award was made to Michel Churci Khodr of Beirut, Lebanon.

Twenty-three year old Mr. Khodr was graduated in June, 1957, from The American University with a BS (ME) degree. "A Study of Central Concrete Mixing Plant" is the subject of his thesis to be published in June, 1957, by the School of Engineering.

Mr. Khodr's academic record is excellent and he has remained in the upper ten of his class throughout his undergraduate years. His command of the English language is very good. Because of his unusual aptitude for science and engineering, he wishes to take general rather than special courses, working toward his MS degree in mechanical engineering. When Mr. Khodr completes his training he will return to Lebanon where engineers are badly needed.

The National Board has approved the recommendations and the Institute of International Education in New York City will secure a tuition scholarship for him and make all arrangements for him while in the United States. Our scholarship amounts to $1500 for maintenence, books, health insurance, and incidentals mandatory while here.

The recipient of last year's Calvin Rice Scholarship, Nick Koumoutsos of Greece, will work during the summer so he can pay for another semester at Illinois Institute of Technology to complete his thesis; he then expects to return to Greece. He has often expressed his gratitude for Auxiliary help and to the Chicago Section for the many courtesies extended to him.

The 1957–1958 Committee comprises the following personnel: Mrs. W. H. Byrne, Mrs. George T. Feldbeck, Mrs. J. W. Wilkenfeldt, Mrs. C. Higbie Young, and Mrs. Allan R. Cullimore is chairman of this Committee.

▶Student Loan Fund

Our Committee reports continuing need for this active Auxiliary arm. Eight loans have been granted since January, 1957, totaling 3250. There are 33 loans outstanding, representing original grants apportioned to students in 22 different institutions. We are grateful for Section and individual contribution to this all important fund. More information will be forthcoming at a later date. Mrs. C. Bertelsen, Mrs. H. R. Kessler, Mrs. E. J. Sharkey, Jr., Mrs. J. C. Somers, and Mrs. W. D. Friend, chairman, make up this Committee.

IMechE Meetings

Oct. 1–3, 1957
Lubrication and Wear, 150 papers IMechE, London (See "ASME Coming Events," p. 901.)

February, 1958
Technology of Engineering Manufacture, 60 papers, IMechE, London

Autumn, 1958
International Conference on Gearing

Note: The foregoing calendar of The Institution of Mechanical Engineers' (Great Britain) meetings is published as a service to members of ASME. Further information relating to complete programs and available papers may be obtained from The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1, England. Preliminary programs also are published in *The Chartered Mechanical Engineer* (IMechE) which is on file in the Engineering Societies Library, 29 West 39 St., New York, N. Y., and other libraries throughout the United States and Canada.

ASME Codes and Standards Workshop

Face-to-Face and End-to-End Dimensions of Ferrous Valves Revised

By W. P. Kliment, Chairman, Sectional Committee B16

THE American Standard on Face-to-Face and End-to-End Dimensions of Ferrous Valves, B16.10, one of many in a series under the jurisdiction of Sectional Committee B16, has been completely reviewed and revised. This standard serves a most useful purpose to users and producers. The new issue, which will replace B16.10-1939 (Reaffirmed, 1947), will contain complete information on face-to-face and end-to-end dimensions for gate, plug, globe, angle, check, and control valves in cast iron and steel.

The standard will be much more comprehensive than before and will reflect such important changes as the increase in end-to-end lengths on 150-lb steel welding end gate valves. To illustrate the coverage the following are some of the additional products included: pipeline gate valves, drilling through valves, and control valves, which are presently covered in other publications. This Standard is used extensively by the engineering profession in the determination of laying lengths in piping construction.

Code for Pressure Piping—

Case No. 27

Inquiry: May bolting material conforming to ASTM A193, Grade B7, be used at temperatures not lower than −50 F?

Reply: It is the opinion of the Committee that bolting materials conforming to ASTM A193, Grade B7, liquid quenched and tempered, with ASTM A194 Class 2H nuts, may be used under Sections 3 and 5 of ASA B31.1-1955 on standard ASA flanges at temperatures not lower than −50 F without impact test.

Case No. 28

Inquiry: Are steel pipe flanges, flanged fittings, and flanged valves, having raised faces and using gaskets of materials, constructions, and dimensions conforming to MSS Standard Practice SP-47, permissible as ASA B16.5-1953 Class A rated flanged joints under Section 3 of ASA B31.1-1955, Code for Pressure Piping?

Reply: It is the opinion of the Committee that flanges having raised faces, and using gaskets of materials, constructions, and dimensions within the limits stipulated by MSS Standard Practice SP-47, are satisfactory for use as ASA B16.5-1953 Class A rated flanged joints under Section 3 of ASA B31.1-1955, Code for Pressure Piping.

R. H. Shannon Named Chairman of B31 Nuclear Piping Subcommittee

ROBERT H. SHANNON, Mem. ASME, of the United Engineers and Constructors, Inc., has been appointed chairman of the B31 Special Committee on Nuclear Piping. The committee was established to advise the present Section Subcommittees to the end that these Sections will contain adequate provisions for piping in nuclear installations, covering materials, design, fabrication, and inspection.

Mr. Shannon received his BS(ME) from the Agricultural and Mechanical College of Texas in 1941. He is a member of the Society and the Atomic Industrial Forum. From 1943 to 1946 he served in the United States Navy as Ship Repair Officer (Machinery), joining the United Engineers and Constructors, Inc., in 1948. While working for this company, he was assigned to the Knolls Atomic Power Laboratory on industry-co-operative basis. During the period 1954–1956, Mr. Shannon was co-author of a nuclear engineering series appearing in *Power* from July, 1954, to July, 1956, and coauthor of a book, "Nuclear Power Engineering," published by McGraw-Hill Book Company. At the present time, he is director of the nuclear power development department of the United Engineers and Constructors, Inc.

C. T. Blake appointed chairman of B5 Technical Committees

Charles T. Blake Named Chairman of B5 Technical Committees

CHARLES T. BLAKE, Mem. ASME, has been appointed chairman of B5 Technical Committee No. 4 on Spindle Noses and Collets for Machine Tools, and of B5 Technical Committee No. 11 on Chucks and Chuck Jaws. Mr. Blake is director of engineering of The Warner & Swasey Company, Cleveland, Ohio.

He was born in Cleveland in 1913, and has resided in Shaker Heights, a suburb of Cleveland, most of his life. He was graduated from Cornell University in 1935 with an ME degree. He started with Warner and Swasey immediately upon graduation as an apprentice in the machine shop. After several years working in various departments in the company, including engineering, sales, and advertising, he was appointed purchasing agent in 1946, serving in that capacity until 1953, when he was transferred to engineering as assistant to the vice-president. Mr. Blake was named director of engineering Jan. 1, 1957.

He was chairman last year of the Technical Standards Committee of the National Machine Tool Builders' Association. He also had been appointed ASA delegate to the meetings of the International Standards Organization held this past summer.

Junior Forum

Conducted for the National Junior Committee

By H. N. Weinberg,[1] Assoc. Mem. ASME

Do Engineers Stand a Chance in Small, Private Enterprise?

We feel the following letter is of pertinent interest to the Associate membership. If any of the Associates or Members have any comments or suggestions which they feel would be helpful, we would be happy to forward their replies to Mr. Peev.

85 Hillsdale Ave. West
Toronto, Canada

The Editor
MECHANICAL ENGINEERING
29 West 39th Street
New York 18, New York

Gentlemen:

At a time when big corporations merge to form huge industrial concerns, when established firms diversify to become even bigger, and when the entire industry is clamoring for engineers, it might be out of place for an engineer to think of going into business for himself.

But even though the great North American pioneering spirit seems to be dying out, even when the search for new frontiers has given way to a search for security, there are still people who are willing to forego the benefits of a guaranteed pay check and a retirement plan. There *are* people who refuse to become prey to domestication and complacency, and would like to start their own business which they can run according to their own concepts, and where they develop their own ideas.

These people are generally young, ambitious, but lack the necessary capital. We hear and read that the small private enterprise is essential to our economy and our way of life. But where are the opportunities for starting such an enterprise? How to get it financed? What are the chances of survival against the competition from the powerful corporations?

Recently I saw an article entitled "Going into Business for Yourself?" in the June, 1956, issue of *Industrial and Engineering Chemistry*. It gave an interesting survey of opinions from people who know something about it. But they concerned the chemical engineer. He can try his hand at cosmetics, cleansers, semi-raw chemicals, plastics, and so on.

What interests me, are the fields that are open and promising for the mechanical engineer who is thinking of a small manufacturing business. Is there a demand for small machines or components that can be made in a shop with a few and inexpensive machines? Could he and should he think, for instance, of the air-conditioning field, acquiring mass-produced components (such as motors, compressors, coolers, and the like) and assembling them into a unit of his own design? Are there any new fields, such as the atomic industry, where a small business could play a useful role?

These are only a few of the questions that come to mind. Wouldn't MECHANICAL ENGINEERING be the right magazine to publish a study of the problem? The majority of the articles appearing in it have been from the point of view of the big corporation. Wouldn't it be fair to consider the needs, interests, and problems of the small, private enterprise, and the men who are willing to risk it?

Sincerely,
Alexander W. Peev,[2]
Assoc. Mem. ASME.

[1] Process engineer, Esso Research and Engineering Company, Linden, N. J.

[2] Mechanical Engineer, plant-engineering department, Colgate-Palmolive, Ltd., Toronto, Ont., Canada.

State Boards for Engineering Registration

The following is a continuation of the list of State Boards persons to query.

Maine State Board of Registration for Professional Engineers, Bryant L. Hopkins, Secretary, Box 103, Waterville, Me.

Maryland State Board of Registration for Professional Engineers and Land Surveyors, J. W. Gore, Secretary, 1101 Key Highway, Baltimore 30, Md.

Massachusetts State Board of Registration for Professional Engineers and Land Surveyors, Mrs. Gertrude J. Cammon, Secretary, to Board, Room 34, State House, Boston, Mass.

Michigan State Board of Registration for Architects, Engineers, and Land Surveyors, Henry G. Groehn, Executive Secretary, 1604 Cadillac Square, Detroit 26, Mich.

Minnesota State Board of Registration for Architects, Engineers, and Land Surveyors, Miss Helen D. Carlson, Executive Secretary, 316 New York Bldg., St. Paul 1, Minn.

Mississippi State Board of Registration for Professional Engineers, O. B. Curtis, Sr., Secretary, P. O. Box 3, Jackson, Miss.

Missouri State Board of Registration for Architects and Professional Engineers, Mrs. Clemmie V. Wall, Secretary, Box 184, Jefferson City, Mo.

Montana State Board of Registration for Civil Engineers and Land Surveyors, E. R. Dodge, Secretary, % Civil Engineering Department, Montana State College, Bozeman, Mont.

Nebraska State Board of Examiners for Professional Engineers, and Architects, Roy M. Green, Secretary, 210 Ferguson Hall, University of Nebraska, Lincoln 8, Neb.

Nevada State Board of Registered Professional Engineers, Stanley G. Palmer, Secretary, % College of Engineering, University of Nevada, Reno, Nev.

Policies on ASME Budget 1957–1958

THE following statement of policies with the schedule of income and expense constitutes the Budget for 1957–1958.

1 A continuous effort will be made to collect dues.

2 No appropriation shall be made by Council without first referring back to the Finance Committee for recommendation. Before a liability is assumed the means for paying it shall be provided.

3 No new activity shall be undertaken without definitely showing that the funds required to support it will be available without decreasing the appropriations for existing essential activities, giving the consideration to the administrative expense that may be involved. When a new activity is authorized if the additional funds to support it are not

(Continued on page 910)

Combined Analysis of Expenditure Budget 1957–1858

Under Committee Supervision

Publications, Standards, Codes, and Research	Direct Expenditures	Joint Bodies	Members Travel	Printing & Distribution	Office Expense	Total
Mechanical Engineering text pages (excluding student copies)				$135,000.00	$ 70,934.00	$ 205,934.00
Mechanical Engineering advertising pages (excluding student pages)				225,100.00	181,767.00	406,867.00
Transactions (including *Journal of Applied Mechanics*)				120,300.00	47,346.00	167,646.00
Membership List				10,000.00		10,000.00
"Know Your Society" (organization charts)				1,000.00		1,000.00
ASME Catalog				55,000.00	28,145.00	83,145.00
Publication Sales (except standards, codes, and research reports)				91,700.00	31,756.00	123,456.00
Standards and Codes		$ 2,250.00		92,000.00	116,633.00	210,883.00
Research				1,300.00	26,785.00	28,085.00
General Society Activities						
Society Meetings	$ 27,600.00		$ 1,110.00		33,395.00	62,105.00
Public Relations	10,000.00				18,520.00	28,520.00
Sections (including Regional Vice-President, Administrative Committee and Regional Delegates Conference)	90,000.00		28,500.00		30,069.00	148,569.00
Professional Divisions	24,150.00				43,099.00	67,249.00
Student Sections (including copies of Mechanical Engineering text and advertising pages)	13,000.00		11,000.00	59,000.00	20,508.00	103,508.00
Admissions					28,122.00	28,122.00
Development					17,223.00	17,223.00
Awards	1,000.00				6,000.00	7,000.00
Lectureships			2,000.00			2,000.00
Civic Affairs Committee	500.00					500.00
Membership Development			3,000.00			3,000.00
General Society Administration						
Council and President	6,300.00		11,000.00			17,300.00
Professional Services	11,100.00					11,100.00
Nominating Committee			3,500.00			3,500.00
Retirement Fund	48,000.00					48,000.00
Joint Activities						
Engineering Societies Library		22,680.00				22,680.00
ECPD		3,600.00				3,600.00
Engineers Joint Council		9,500.00	1,000.00			10,500.00
Engineering Societies Personnel Service, Inc. (reserve)		500.00				500.00
Registration (National Council of State Boards of Engineering Examiners)		500.00				500.00
Contribution—New Engineering Center		1,875.00				1,875.00
Council for International Progress in Management		500.00				500.00
Indirect Expense						
Secretary's Office					61,890.00	61,890.00
Accounting Department					62,855.00	62,855.00
General Service (stores, mailing, filing, etc.)					125,640.00	125,640.00
General Office (rent, insurance, etc.)					76,000.00	76,000.00
	$231,650.00	$41,405.00	$61,110.00	$790,400.00	$1,026,687.00	$2,151,252.00

(Continued from page 908)

directly available from the unappropriated income, Council shall say what activity shall be curtailed or suppressed to permit transference of the funds required to support the new activity. If the budget of expenses is to be reduced, the Council shall say what activity shall be curtailed or suppressed.

4 The Society shall hold general meetings with expense chargeable to the Budget. A fee shall be charged to nonmembers for admission to general or technical sessions at these meetings of the Society according to rules established by the Board on Technology. No payments will be made for rental of rooms for the holding of technical sessions.

5 Council meetings shall be held at the place and time of the Annual and Semi-Annual Meetings.

6 Within the provisions of the Budget, Vice-Presidents shall be expected to visit Sections and Student Sections and attend Student Section Conferences in their Regions or arrange for visits by their representatives.

7 No travel allowance will be provided for Board and Committee meetings or for Chairmen attending Council meetings except upon special provision of Council or the Executive Committee.

8 Eight Regional Administrative Committee meetings will be held within the provisions of the Budget.

9 A Regional Delegates Conference will be held at the place of the Semi-Annual Meeting.

10 The Nominating Committee including the first alternates shall hold a Selection Meeting and an Organization Meeting at the Semi-Annual Meeting within the provisions of the Budget.

11 The following uniform basis of contribution toward travel expense shall be adopted.

(*a*) For meetings of the Council, the Vice-Presidents (when meeting at some other time and place than the Council), the Nominating Committee, the Regional Administrative Committee including Regional Representatives on Regular Nominating Committee, and the Regional Delegates Conference.

Thirteen cents per mile one way (calculated by standard railroad route) plus $6 per day or major part thereof for time engaged in business at meeting and for trips over 100 miles for travel time to and from the meeting not to exceed round-trip travel time by standard railroad route.

These payments will be made upon submission of a report on a form supplied by the Secretary.

(*b*) For Student Branch Conferences—

Engineering Societies Personnel Service, Inc. (Agency)

THESE items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York
8 West 40th St.

Chicago
84 East Randolph St.

Detroit
100 Farnsworth Ave.

San Francisco
57 Post St.

Men Available[1]

Engineering or Manufacturing Administrator, BS (ME), 42, 15 years' broad experience in plant and engineering administration and supervision including design, development, production, manufacture, methods, standards, systems, procedures, planning, labor management relations, sales promotion, customer relations, and heavy correspondence. ME-420.

Director, design, development, or research; MSME, registered. Will upgrade your product or technical staff, or develop new product or product line. Over 20 years of stable and progressive experience from design fundamentals to coordination of design, development, and research activities in light to heavy machinery, appliances, ordnance, etc. ME-421.

Manager Engineering, ME, 34; seeks challenging managerial position, mechanical, industrial, product, and plant engineering background. Organization development, engineering planning, supervision, and control experience. Extensive technical and managerial training and application. Prefers East. ME-422.

Sales and Promotion Engineer, BSME, BA Chemistry, 35. Seeking responsible position utilizing engineering, sales, advertising, and business knowledge. Excellent background in sales engineering, administration, creative advertising and promotion, technical writing and engineering design. Experienced in the paper, aircraft, heating, and air-conditioning industries. Technical background included plant engineering, research, development, design, and purchasing. Location optional. Me-423.

Hydraulics Engineer, BIE, 28, two years' broad manufacturing experience, plus three years development of lubrication systems, pumps, filters, hydraulic reservoirs, and test equipment, including one and one-half years' supervision. Prefers metropolitan or New England. ME-424.

Development Engineer, BSME, 34, 11 years in research and development of light and medium industrial machinery. Experience in functional and economic analysis, supervising development personnel, liaison with customers, suppliers, sales and production departments. Anywhere in U.S. ME-425.

Plant Engineer, BS (ME), 49; 20 years' experience in drafting, design, engineering, and maintenance in the chemical and petro-chemical industry. Prefers U.S.A. ME-426.

Assistant Chief Engineer or Project Engineer, BSME, 46; 21 years' extensive experience in light to heavy mechanical and electromechanical product and process equipment development and design. Also experience in supervision, plant engineering, and customer liaison. South or East. Me-427.

Welding Engineer, BME, MMetE, 29; six years' research and development, industrial production including welding, powder metallurgy, semiconductors; presently staff metallurgist of research laboratory. ME-428.

Mechanical Engineer, 35, professional engineer, supervisory administrative experience in all phases of plant engineering, building and grounds facilities. Design, construction, operation, maintenance of mechanical services including heating, ventilation, air conditioning, refrigeration. Varied experience with industry, consulting, contracting. Now plant superintendent for large industry with multiplant operation. Prefers mild climate. ME-429.

Director of Engineering, BS and MS; 48; 22 years' experience with four large manufacturing companies, all high precision small parts products, as designer, director of R&D, and manager of research. Wants challenging opportunity production. Prefers Calif. or West. ME-430-400 San Francisco.

Production Engineer or Chief Engineer of small manufacturing firm, BSME, 40; experience in research, design, production of small electromagnetic and electromechanical devices in communication field; has supervised small groups in research and design. Will locate in area of desirable firm. ME-431-825 Chicago.

Mechanical Engineer Manufacturing, BS, 33. Extensive experience in tooling, process planning, methods analysis, equipment selection, cost estimating, plant layout, maintenance, product design, evaluation, and development work. Familiar with machine shop, tool room, sheet metal, heat-treating and foundry equipment and practices. Will relocate. Desires new, challenging responsibilities with expanding opportunity. ME-432 San Francisco.

Chief Engineer or Assistant, BME, 43; 20 years' experience in the design and development of machinery containing hydraulic and electrical components; 13 years' broad experience, seven years' supervision. Considerable customer contact work. Registered Conn. Prefers East and southern Calif. ME-433.

Mechanical Engineer, BSME; PE license; 33. Experience in heavy machine design layout, all-round experience in shop practice as mechanic and machinist. Language background. Desires a good position in industry, permanent. ME-434.

Engineer Executive, M.E.; 33; eight years' usually broad business experience; manufacturing, process and plant engineering, technical sales; and purchasing in small company management and major corporation. Prefers greater New York area. ME-435.

Positions Available

Engineers. (*a*) Industrial engineer, graduate, under 35, minimum of three years' experience, for methods analyses of materials handling techniques, office procedures, vehicle utilization, and transportation work in general; analysis, development, and application of work measurement

[1] All men listed hold some form of ASME membership

To Faculty Adviser, 11 cents per mile one way (calculated by standard railroad route) plus $6 per day or major part thereof for time engaged in the Conference and for trip over 100 miles for travel time to and from the meeting not to exceed round-trip travel time by standard railroad route.

To Faculty Advisers in metropolitan area who do not travel over 100 miles, $6 per day or major part thereof for time engaged in the Conference plus a miscellaneous allotment of $3.

To the Student delegation, 18 cents per mile one way (calculated by standard railroad route).

(*c*) Visits of Presidents and Vice-Presidents or their designated representatives to Sections, Student Sections, and other Society functions are paid as out-of-pocket expense within budgetary limits prescribed.

12 Payments to the Sections for Operation shall be on the basis of the Standard Formula plus twenty-five per cent.

The Standard Formula is: $3.50 per member for the first 75 paid-up members, $1.50 per member for the next 925, $1.10 per member for all over 1000; $150 to each Section for each authorized Subsection, and $25 to each Section for each authorized Group.

Supplementary payments equal to one-third of a dollar for each paid-up member in the Section on September 30, this supplementary payment to be made only on a specific request from the Section showing necessity for it, and with the approval of the Vice-President, the additional payment to be made with the second payment to the Section.

Any payments to a Section in addition to those paid on the Standard Formula shall require authorization by Council.

Payments by the Section shall be made in accord with the Sections Operation Manual, and the Secretary's Staff has authority to deny reimbursement for payments not so made.

13 Payments to the Student Sections for operation shall be on the basis of: 15 through 50 Student Members, $25; for the next 50 Student Members, 50 cents per Student Member; and for all over 100 Student Members, 25 cents per Student Member.

14 Grants of Society funds for Sections, Division, and Student Section operations shall not be used for social events.

15 The Society shall have three representatives on the American Standards Association.

16 No publications shall be printed for sale unless there is reasonable assurance of sufficient orders to pay for the cost.

to afore-mentioned; supervisory training and development. Knowledge of methods, time and motion desirable. $8000. (*b*) **Operations research engineer,** graduate, under 35, minimum of three years' experience in OR theory and practical survey work. Knowledge of various statistical, mathematical, and scientific techniques used is required. Will conduct studies using established methods of analysis in the OR field to assist in making top policies and plans in fields such as: determination of optimun operating efficiency in terminal operations; scheduling use of vehicles to obtain maximum benefits, etc., to start, about $9000. New York, N. Y. W-4877

Manager, Engineering Standards and Specifications, BS preferably in electrical, administrative, mechanical, or industrial engineering, broad knowledge of the physical sciences and definite leanings toward administrative phase of engineering operation. Minimum of five years' experience as standards engineer with an electrical manufacturer, or employment in some technical capacity, with considerable knowledge of government specifications and standards. Background should include administrative or supervisory work. Must have a flair for writing. Will have direct administrative and technical supervisory responsibility for the performance of a group of standards engineers engaged in preparation and co-ordination of company specifications and standards, and the interpretation of government and commercial standards and specifications; will train less experienced personnel; will serve on Standards and Specifications Committee, etc., $8400–$9600. Ohio. W-5176

Mechanical Engineers. (*a*) Hydraulic circuit designer, graduate mechanical, good analytical ability, strong in fluids, strength of materials, machine design, and math. Must have five years' experience in design and development of hydraulic (Oil) circuits. Experience in manufacturing processes of job shop type important. (*b*) Applications engineer for hydraulic application work for major sales division of leader in field. Good engineering background and experience needed. Interest, opportunity, plenty of work, and job responsibility. Conn. W-5186

Production-Planning Engineer, industrial or mechanical engineering graduate, at least eight years' heavy machine shop and metal-forming experience. $8000–$10,000. Western Pa. W-5191

Mechanical Engineer, for power plant engineering, eight to ten years' experience in application of engineering principles to specific plant power requirements, including extensive experience in design and operation of power, refrigeration, ventilating and air conditioning equipment, and in the application of power costs. Will also include making recommendations for replacement of equipment and selection of new equipment, advise plants on operation and maintenance of power equipment, and develop design recommendations. Del. W-5209

Assistant Director, School of Mechanical Engineering, college graduate or equivalent in mechanical engineering, at least two years' actual work experience in the field of mechanical engineering. Writing or teaching experience desired. Must learn the direction and preparation of instructional materials and instructional services which will include writing and editing instruction tests and examinations, etc. $5660–$7547. Pa. W-5211

Chief Industrial Engineer, mechanical or industrial engineering graduate, five years' experience, three of which were supervising methods, time study, standards, production lines. Any experience in needle trades desirable. $10,000. Conn. W-5213

District Sales Representative, industrial insulation products, 35–45, mechanical or chemical graduate, experience in engineering sales with background in power plant, refinery, or piping-system construction. Knowledge of insulation desirable. Will deal primarily with major accounts in well-established territory, including architectural-engineering firms, boiler manufacturers, large insulation contractors, etc. To $10,000. Territory, New York metropolitan area. W-5217

Engineers for both street lighting and commercial fluorescent lighting. (*a*) Street lighting test engineer to head up entire program, graduate engineer, street-lighting experience or associated public-utility experience. (*b*) Junior engineers, graduate, one to three years' experience in design and development project engineering. (*c*) Industrial designer in the commercial fluorescent-lighting area qualified to take on a certain amount of product engineering design and development work. Salaries open. Mass. W-5228

Department Manager, mechanical graduate, or equivalent, to 47, background in production or manufacturing engineering. Should be qualified to translate production schedules into parts and assembly orders for efficient machine loading, provide tool requirements, improve methods, control manpower, establish effective inspection procedures and direct effort of all personnel and facilities. Employer pays fee. To $13,000. Midwest. W-5231

Director of Engineering, graduate mechanical, familiar with air pumps, compressors, and blowers. Background in engineering supervision and as a chief engineer. Will review product engineering needs and establish budget and planning in co-operation with top management, sales, and research to insure new product development and existing product improvement and maintenance of quality standards. To $15,000, plus bonus. Employer pays fee. Midwest. W-5232-D-3954

Research Director, graduate mechanical, to 60, background in the field of positive air-moving equipment preferred. Will plan and direct, within budget limitations, research projects leading to product improvement and explore commercial possibilities of technological advances which could be applied to product. Will provide sales organization with test data which may be translated into profit. To $15,000. Employer will pay fee. Midwest. W-5233-D-3955

Product Engineers, graduates, not over 30, some practical experience in machine-shop methods, machine design, planning, processes, standards, and an appreciation of labor relations. Salary based on ability and experience. Excellent opportunities for advancement. Company pays placement fees. N. Y. State. W-5236

Chief Mechanical-Design Engineer, to 52, light automatic machine design, packaging, assembly. $10,000–$12,000. Presently New York City; after six months plant is moving to Conn. W-5238

Chief Process Engineer, extensive background in production engineering, tooling, and methods, as applied in a precision machine shop. High-level position requiring man of executive caliber. To $13,000. Conn. W-5241

Teaching Personnel, fields of fluid mechanics, soils mechanics, and general engineering. Should have had postgraduate training preferably at the PhD level and some design experience. Rank and salary commensurate with qualifications. Pacific Northwest. W-5248

Manufacturing Executive, graduate mechanical, to 45, experience at executive level in heavy metalworking plants, knowledge of steels and alloys, especially cold processing. Must have ability in developing and improving methods and equipment. Interest in and some contact with industrial sales and market development for technical products. $30,000–$35,000, plus bonus. East. W-5250

Stress Analyst, 30–40, degree in metallurgy or mechanical engineering, at least five years in stress analysis work (computation, testing, and evaluation) covering ferrous and nonferrous metals; should be familiar with or have worked in powdered metals, plastics, other synthetics, and wood; experience should preferably have been in research engineering, or development engineering department of a manufacturer interested in product development and improvement. Will be responsible for examining, evaluating, and passing upon the stress factors involved in the use of materials in standards, special and new units and their components. Excellent opportunity. Midwest. W-5252

Executive Vice-President, master's degree in business administration, electrical background, for manufacturing company in electrical communications fields. Must have considerable experience in financial aspects of a large company. $20,000–$25,000. Northern N. J. W-5259

Senior Industrial Engineer, experience in time study, rate setting, and development and maintenance of basic standards. Should have had experience in the development and administration of methods-improvement program for cost reduction and in the evaluation of savings. Ability to supervise junior engineers. Will establish measures of production performance on various plant operations for the purpose of cost control and providing management with an operating "yardstick"; will analyze operations to initiate and carry out original programs to reduce costs and improve operations, etc. Salary open. Md. W-5266

Sales Engineer, well-established factory rep-

resentative, for bulk materials handling and storage, dust-collecting equipment; about 30, engineering degree desirable.—Sales aptitude plus technical know-how. Car required. Some travel to south central Ohio involved. Headquarters, Cleveland, Ohio. W-5270.

Construction Engineer, Mechanical, graduate, 35–45, minimum of ten years' experience in design and supervision of mechanical installations for industrial and commercial buildings, and hospitals including installations for water services; plumbing and sewers; heating, ventilating, air conditioning; steam generating and distribution; etc. Will act as consultant and adviser to foreign governmental agencies and foreign private enterprises. Salary commensurate with past earnings and experience; transportation expenses and quarters allowance. Climate subtropical. Duration 11 months with possibility of extension. Far East. F-5271.

Product Managers, staff positions, reporting to general manager, to develop and co-ordinate the execution of sales, engineering, purchasing, manufacturing, and financial plans. Will work with engineer to obtain design and cost acceptance for new or improved designs; co-operate with manufacturing and purchasing in introducing and producing new products; assist in development of profit plans and financial controls for product operations, etc., covering oil-field accessories. $12,000–$15,000, plus bonus. Southwest. W-5275.

Sales Manager, to organize and administer a sales department for company manufacturing oil-field accessories. Will direct activities of planning section of the sales department, direct the activities of the various sales representatives, and co-ordinate efforts of customer service sections; direct activities of customer service, warehousing, and price analysis; work with general manager in conceiving and executing company objectives, policy, and plans, etc. $20,000–$30,000. W-5276.

Assistant Director, engineering school, degree in industrial engineering, at least two years' actual work experience in varied fields of industrial engineering. Experience must include work in plant layout and production engineering or design. Writing of technical experience desired but not essential. Will be required to learn direction and preparation of instructional materials and instructional services which will include writing texts and examinations. To start, $5400. East. W-5278.

Application Engineer, graduate mechanical or equivalent experience, three to five years' experience in design of air-conditioning and refrigeration systems. Will be required to assist field sales office on system application problems, travel to field offices when necessary to work with either field sales office or consulting engineers on the design of refrigeration and air-conditioning systems; work with product-sales departments on application problems that involve a number of different product lines. Salary open. Midwest. W-5282.

Machine Designers, three, preferably graduates, at least five years' experience on mechanical layout of special automatic packaging, printing, textile, or similar machinery. Experience must be in the field of special machinery. Tool and die or plant layout experience not acceptable. Basic duties will be full time board work on layout of special automatic mechanisms and machinery for manufacturing various wood, paper, and pulp products. $7200–$9600. Ohio. W-5283.

Superintendent of Manufacturing, electrical, mechanical, or industrial engineering graduate, at least five years' experience in TV and radio fields in a supervisory production position. $10,000–$12,000. N. J. W-5286.

Engineers. *(a)* Process engineers, mechanical graduates preferred, but will consider welding or metallurgical engineers, to design jigs and fixtures and equipment for new core design. Write specifications and procedures for core assembly. Production operation. *(b)* Process engineers for core manufacturing department, preferably metallurgical engineers but will consider mechanical or welding. Will interpret plans and specifications, prepare material and labor estimates, summarize data; write equipment specifications, and develop operating procedures. *(c)* Mechanical and physical testing engineer in materials development laboratory to devise test techniques and supervise execution; write reports on material behavior and co-ordinate with other staff members on new developments. Salaries open. Applicants must be United States citizens. New England. W-5289.

Industrial Engineer, 35–45, preferably IE degree or ME, industrial experience or graduate training. Should have a minimum of ten years' industrial engineering work with stress on methods, particularly materials handling. Some experience on railroads, in shipping or terminal activities would be helpful. Knowledge of Spanish desirable. $8000–$12,000. Some travel to tropics. Company will negotiate placement fees. Headquarters, southern United States. W-5292 *(b)*.

Project Engineer, graduate mechanical or equivalent, five to ten years' experience in product development and design. Strong on creative ability. Must be cost conscious and have practical knowledge of metalworking operations. Should have ability to handle development projects from project definition through the pilot stage. Western Pa. W-5297.

Engineers. *(a)* Assistant chief engineer, under 40, mechanical or electrical graduate, at least five years' supervisory design and development experience covering precision instruments, electromechanical devices and testing equipment. $12,000–$15,000. Company pays placement fee. *(b)* Assistant sales manager, under 40, mechanical or electrical graduate, sales and office administrative experience covering precision electromechanical equipment. Some traveling. $10,000–$12,000. Company pays placement fee. Conn. W-5304.

Assistant Manager, mechanical graduate, at least five years' supervisory steam-power plant design, project engineering, and administrative experience. $11,000. Eastern Canada. F-5310.

Manufacturing Engineer, degree in engineering, ten to 15 years' experience in manufacturing, preferably in small metalworking industries, machining nonferrous castings, forgings, bar and strip stock. Must be familiar with and able to direct manufacturing processes on high production machinery used in the manufacturing of such materials. Should be familiar with production control systems and manufacturing scheduling. To $10,000, plus fringe benefits. *(b)* Methods engineer, engineering degree preferred, considerable experience in tools, equipment, and machinery used in the manufacturing of nonferrous castings, forgings, bar and strip stock. Assignment for next year will be in engineering design, specifications, and procuring of machinery, equipment and tooling to set up a newly constructed building; engineer transfer of tools, machines, and equipment. After transfer, will take over regular duties of methods engineering. To $8500, fringe benefits. Pa. W-5313.

Production-Development Engineer, preferably graduate mechanical, 25–45, four to five years' experience in product development, application or allied fields. Should be acquainted with metal working, i.e., machining, fabrications, and welding. $8340–$9000. West Coast. W-5316.

Equipment Superintendent, mechanical, to 50, ten or more years in maintenance of heavy earth-moving and construction equipment and know costs and sources of supply. To supervise all maintenance and machine shop equipment for repair and maintenance of heavy equipment, bulldozers, crawlers, tractors, Euclids, etc. Must be good organizer, ability to command respect for a building supply and construction company. $15,000. Employer will pay the placement fee. Southwest suburb of Chicago. C-6388.

Industry Engineer—Major Electric/Steam Apparatus: EE, ME, to 40, recent graduate to ten years' experience, interest or knowledge of use of major equipage in particular industries (steel, cement, marine, power, manufacturing, etc). Will provide technical information to local or regional offices relative to application of major electric or steam apparatus within a particular industry. Require development of complete knowledge of needs of particular group of clients of sales offices in applying such apparatus. For major manufacturer. Continuing promotional program to develop professionally and managerially. Salary commensurate with experience, plus fringe benefits. Headquarters, eastern U. S. S-3048.

Product Engineer—Control, Switchgear, Steam Power, EE or ME, to 40, recent graduate to ten years' experience, solid interest or good knowledge of application of single, major apparatus line (electric or steam industrial controls, switchgear apparatus, rotating machinery). Will treat with technical problems relative to use and application of particular line of equipment to any industrial or other use. Require development of technical quality with emphasis on commercial aspects to provide special information to clients and sales in local or regional offices of major manufacturer. Continuing promotional program to develop professionally and managerially. Salary commensurate with experience, plus fringe benefits. West or elsewhere in U. S. S-3049.

Consultant and Application Engineer—Major Apparatus, EE, or ME, to 35, recent graduate to five years' experience; knowledge or substantial interest in technical and commercial aspects of electric and steam apparatus used by utilities, general and heavy industry, marine, municipal, transporation, construction, or mining. Will consider problems relative to combining major equipment in systems, products, or for individual application and provide technical assistance to clients and support to sales force in local or regional offices of major manufacturer. Continuing program to develop professionally and managerially. Salary commensurate with experience, plus fringe benefits. West or elsewhere in U. S. S-3050.

Candidates for Membership and Transfer in ASME

THE application of each of the candidates listed below is to be voted on after Sept. 23, 1957, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and ●Transfers

California

ANDERSEN, HOWARD L., Upland
ANDREASEN, JAN A., San Francisco
●BRENT, CHARLES G., Whittier
●CARTER, HUGH C., Long Beach
CHAIKEN, RALPH G., Los Angeles
CORTELYOU, JOHN T., Los Angeles
●COYNE, ROBERT F., Los Angeles
EVANS, DAVID J., Los Angeles
HAGEN, JOSEPH W., Los Angeles
HENDERSON, RICHARD L., San Francisco
●LEPPERT, GEORGE, Stanford

●Transfer to Member or Affiliate.

MOSS, MARVIN A., Sherman Oaks
NAGORSKI, RUSSELL P., South Gate
●PAULDEN, HENRY A., Canoga Park
ROBERTS, CLEMENT A., Alameda
RUSSELL, JOHN L., JR., Downey
SCHEIB, JOHN C., JR., Los Angeles
WAINRIGHT, OSCAR L., JR., Whittier
●WILDE, THOMAS B., Huntington Park
ZIZICAS, GEORGE A., Los Angeles

Connecticut

BARTOSH, ANDREW G., Norotor Heights
MURPHY, JAMES S., Middletown
VAN PELT, ADOLPHE P., Darien

Delaware

●CAMBRIDGE, JOHN D., Newark

District of Columbia

FORD, JOHN J., JR., Washington

Florida

●HAINLIN, ALBERT W., Coral Gables
HENRY, JOHN H., West Palm Beach

Georgia

●THOMAS, FRANK A., JR., Atlanta

Illinois

KRUEGER, DONALD A., Chicago
KUPCHICK, WALTER, Libertyville
NUTTING, ROBERT G., Chicago
YUKNIS, EDWARD, Chicago

Indiana

●NOREN, CLYDE W., Brooklyn

Kansas

REED, JOHN A., JR., Kansas City

Louisiana

BURDETTE, JOSEPH R., Baker

Maryland

PAINE, ROBERT B., Adelphi

Massachusetts

BAREISS, ROBERT A., South Sudbury
●CIRRITO, ANTHONY J., Worcester
●FEINZIG, DAVID S., Brookline

Michigan

ANDERSON, JOHN F., JR., Centerline
●BENYA, EDWARD G., Grosse Point Woods

(ASME News continued on page 914)

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Welbond Valves are winning acceptance among modern steam plants for all high pressure, high temperature valve service.

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- Ventilated, easy grip **handwheel**
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GRESWICK, FREDRRICK A., Royal Oak

Missouri

●MARSHALL, WILLIAM N., JR., Kansas City
MEYER, RICHARD T., Richmond Heights
REHAGEN, CLARENCE T., Kansas City

New Jersey

BIKKAL, JULIUS L., Rahway
BREWSTER, CHARLES A., Highland Park
BROZDOWICZ, ZYGMUNT, Montclair
●ROGACKI, STANLEY P., Bayonne
SCHIESS, HANS H., Metuchen
●SKALANGYA, JOHN, Woodbridge
SPANG, JOHN P., Cresskill
STEELECK, GREGORY R., Livingston
●TAYLOR, ELLIOT L., Whippany
TURNER, JAMES R., Alpha
TYLER, JOHN W., Medford
WIHLBORG, SVEN H., Trenton

New York

ANDRYSICK, CHESTER A., Campbell
AWAN, ABDUL Q., Jackson Heights
BALDWIN, CHARLES W., Utica
CARNEY, HENRY R., Oneida
●HAUKNSTEIN, GEORGE C., Troy
HEILWEIL, MELVIN G., Long Island City
IVEN, MICHAEL S., Wellsville
KACIN, WILLIAM L., Flushing
KETTNER, HEINZ, Horseheads
KURIC, MARTIN P., West Hempstead
●LINDGREN, BERTIL G., Huntington
LUFFRED, ANTHONY J., Corning
MARSHALL, ROY, Olean
MCDOWELL, DAVID W., JR., New York
MITCHELL, NEWELL D., New York
ORDODY, VICTOR Z., New York
REECE, JOHN W., Utica
SCHINDLER, HAROLD J., JR., Rochester
SHALER, DAVID, Long Island City
SPENCER, DAVID G., Endicott
VAN VLEET, ARTHUR J., Elmira
VARRICHIO, RALPH A., New York
●WEINDLING, JOACHIM I., Kew Gardens

North Carolina

●AMIN, RAMAN D., Cary
DEAN, EDWIN L., Charlotte
●HARRISBERGER, EDGAR L., Raleigh
●INSCOE, LINWOOD S., Morganton

Ohio

●AUSTIN, JOHN B., JR., Warrensville Heights
●BATES, JOHN L., Cleveland
●BONI, FRANK, JR., Massillon
●BOTKIN, LAWRENCE A., Dayton
●BUCK, KENNETH D., Cleveland
DREHER, GEORGE K., Rocky River
FELDMILLER, BENNETT W., Mount Vernon
GRIFFITH, KEITH O., Salem
SCHNEIDER, OTTO E., JR., Cincinnati
TEAGLE, WILLIAM C., Cincinnati
VAUGHAN, ARTHUR H., Salem

Oklahoma

STACY, KENNETH, JR., Oklahoma City

Pennsylvania

ADAMS, LUDWIG, Pittsburgh
HANDSCHUMACHER, RICHARD A., Philadelphia
●JOHNSON, HAROLD A., Warren
●KOETHE, WERNER E., Lansdowne
LUCIA, VINCENT J., Philadelphia
OLSEN, GEORGE A., Levittown
●RHOADES, WILLIAM A., Pittsburgh
SCHWARTZENBERG, JOHN W., Philadelphia
SHANNAHAN, DANIEL A., Oil City
WERME, H. WALTER, Erie

South Carolina

CAMPBELL, HARRY M., Spartanburg

Tennessee

FRALEY, LOWELL D., Lookout Mountain
●LEWIS, HENRY F., Tullahoma

Texas

LEWIS, GORDON H., Orange
●NAIL, PAUL C., Houston
●STAFFA, RAYMOND J., Newgulf
THOMAS, DOYLE E., JR., Baytown
TODD, LLOYD H., Texas City
WALKER, JAMES, Houston

Vermont

NITSCHKE, ROBERT C., Springfield

West Virginia

CODY, PAUL, South Charleston
●PHILLIPS, THOMAS M., Charleston

Foreign

ALLEN, WILLIAM H., Pembroke, Bermuda
BOGHOSSIAN, VARTKES O., Aleppo, Syria
CONCIO, MANUEL G., JR., Sampaloc, Manila, P. I.
JODLOWSKI, JAN, Downsview, Ont., Canada
LEANAGE, DON B., Colombo, Ceylon
NATER, CHARLES, Dundas, Ont., Canada

Transfers from Student Member to Associate Member, Class of 1956 6

Obituaries

Joseph Bradley Armitage (1881-1957), vice-president, Kearney & Trecker Corporation, Milwaukee, Wis., died May 30, 1957. Born, Hyde, Cheshire, England, April 10, 1881. Parents, Joseph and Elliott Armitage. Education, English preparatory schools; attended Rhode Island State College. Naturalized U. S. citizen, Providence, R. I., 1904. Married Mary Agnes McNally, 1909, died, 1935. Married 2nd, Bertha M. Lowry, died 1950. Married 3rd, Ann R. Trehan, 1951. Mem. ASME, 1919; Fellow ASME, 1947; Hon. Mem. ASME, 1955. Mr. Armitage held over 115 patents on machine tools and metal-cutting equipment. He was the author of many papers published in technical journals. Mr. Armitage served the Society as a Director at Large from 1947 to 1950. In addition, he was active on at least ten committees in the field of machine-tool standardization. He also served as a vice-president of the Society of Automotive Engineers in 1948; and as a member of the committee on splines of the American Gear Manufacturers Association; the Milwaukee Engineering Society; the Newcomen Society. Since 1920, Mr. Armitage, in association with the Kearney & Trecker Corporation, was personally responsible for many of the major developments in milling-machine design. A pioneer in the field of automation, he leaves a long record of outstanding accomplishments as an engineer and designer in the machine-tool field. Before going to the Kearney & Trecker Corporation, Mr. Armitage had been an assistant designer of milling machines at the Browne & Sharpe Manufacturing Company; and, subsequently, machine designer at the Taft-Peirce Manufacturing Company, and chief draftsman at Narragansett Machine Company.

Harry Richard Byers (1890-1956), president, Harry R. Byers, Inc., Washington, D. C., died Aug. 6, 1956. Born, Denver, Colo., March 11, 1890. Education, attended Colorado School of Mines. Married Sally Mozelle K. Byers, who died 1953. His second marriage to Diane M. Byers ended in divorce April of this year. Assoc-Mem. ASME, 1919; Mem. ASME, 1925. Mr. Byers had constructed one of the first bomb-proof power plants in the world at Pearl Harbor in the early days of World War II. He was also largely responsible for the design of the intake and outlet water lines of the Hoover Dam. In World War I, Mr. Byers served in the U. S. Navy as a lieutenant. Survived by his son, Richard H. Byers.

Howard McCune Chandler (1878-1957), retired designer of sugar factories and equipment, Honolulu Iron Works Company, New York, N. Y. died May 22, 1957 in Milford, Conn. Born, Waynesville, Ohio, March 25, 1878. Parents, Horace Baner and Ella (Johnes) Chandler. Education, BS(ME), Kansas State College, 1903; ME, 1932. Married Eva M. Plumley, 1917. Mem. ASME, 1913. From 1904 until his retirement, Mr. Chandler was associated with the Honolulu Iron Works. After his retirement from that firm he taught briefly at the Polytechnic Institute of Brooklyn. Survived by his widow, and a son, Howard Russell Chandler.

Frank Gardner Cox (1880-1957), retired, died in Wilmington, Del., May 29, 1957. Born, South Hadley Falls, Mass., Feb. 9, 1880. Parents, Gardner and Emma (Howard) Cox. Education, SB, Massachusetts Institute of Technology, 1903. Assoc-Mem. ASME, 1905; Affiliate ASME, 1908. Married Anna Sellers, 1911. Mr. Cox had been a recipient in 1955 of the Society's Fifty Year Pin. Survived by wife and two sons, William S., Darien, Conn.; and F. Gardner, Jr., Wilmington, Del.

George Henry Davis (1863-1957), engineering executive, New York, N. Y., died May 3, 1957. Born, Oswego, N. Y., June 10, 1863. Parents, Samuel A. and Esther T. (Parks) Davis. Education, ME, Cornell University, 1892. Married Katherine McGrath, 1898; children, Philip M. and Putnam Davis. Mem. ASME, 1913. In his long career which began in 1892, Mr. Davis has been a specialist in the design, construction, and management of various public utilities, railways, and industrial plants. From 1895 to 1941, he was a partner and director of the firm of Ford, Bacon & Davis, Inc. He was a vice-president of American Cities Railways & Light Company, from 1907 to 1911; and president, American Cities Company, from 1911 to 1913. In 1918 he prepared a report for the Secretary of War on strategic seclusion of the New Orleans area for airplane and naval bases and an operating terminal. He was also a director of Atlantic Aircraft Corporation, from 1925 to 1927, and Fokker Aircraft Corporation, from 1927 to 1930. Since 1921, he had engaged in general engineering practice and capital management. He was a member also of the American Society of Civil Engineers.

Dion Kanouse Dean (1884-1957), manager industrial division, Foster Wheeler Corporation, New York, N. Y., died Feb. 7, 1957. Born, Waterbury, Conn., April 17, 1884. Parents, Aaron and Malvena K. Dean. Education, ME, Lehigh University, 1906. Married Elsie Orr, 1912, died 1923; married 2nd, Margaret Brearley, 1925. Children, Ruth Orr (Mrs. Dwight B. Herrick), Robert Aaron, and Margaret Ann (Mrs. Thomas M. Ark). Jun. ASME, 1912; Mem. ASME, 1920. Mr. Dean had several inventions relating to heat-exchanger equipment and processing. He was the author of several papers presented before technical societies and published in the technical press. He began his long association with the Foster Wheeler Corporation in 1927 as chief engineer.

Richard S. Dill (1901-1957), chief, heating and air conditioning section, National Bureau of Standards, Washington, D. C., died Jan. 17, 1957. Born, New Bern, N. C., March 23, 1901. Parents, Samuel Lefferts and Elizabeth (Williams) Dill. Education, BS(ME), North Carolina State College of Agriculture and Engineering, 1923. Married Louise A. McCombe, 1937. Mem. ASME, 1938. Mr. Dill was a specialist in R&D testing, heating and air-conditioning equipment, and thermal insulating materials. He has served the Washington Section of the Society as chairman, Budget and Finance Committee; and as a member of the executive committee. He was a member also of the American Society of Heating and Ventilating Engineers.

William Victor Drake (1897-1957), retired vice-president, West Penn Power Company, Pittsburgh, Pa., died May 20, 1957. Born, London, England, Jan. 30, 1897. Parents, William and Minnie Florence Drake. Education, EE, Brooklyn Polytechnic Institute, 1918; post-graduate study, Yale University and University of Pittsburgh. Married Sally Hunter, 1928; one son, William Victor, Jr. Assoc-Mem. ASME, 1927; Mem. ASME, 1935; Fellow ASME, 1954. Mr. Drake joined the West Penn Power Company in 1921 as assistant to the superintendent at the Springvale Power Station. He subsequently held positions as superintendent of power stations, manager of power generation, manager of power production, and assistant vice-president in charge of power production. In 1945 he was selected to head a party of engineers making a survey of power facilities of Formosa and North China for the National Resources Commission. He was recalled to Formosa as a consultant in 1952 in order to survey the power facilities of the Taiwan Power Company. Mr. Drake for many years served the Society as a member of the Executive Committee of the Pittsburgh Section.

Stephen John Farrington (1920-1957), vice-president and manager, S. J. Farrington Iron Works, Inc., Brooklyn, N. Y., Feb. 23, 1920. Education, SB, Massachusetts Institute of Technology, 1942. Assoc-Mem. ASME, 1942.

William Bailey Fogarty (1881-1957?), whose death was recently reported to the Society was a retired commander of the U. S. Navy. Born, Cincinnati, Ohio, Jan. 10, 1881. Education, U. S. Naval Academy, 1901; MS, Massachusetts Institute of Technology, 1905. Mem. ASME, 1945. Mr. Fogarty was in the U. S. Navy until his retirement after over 30 years of service. During his service in the Navy, Mr. Fogarty was concerned principally with the examination and criticism of plans involving many mechanical devices and auxiliary machinery installed on Naval vessels.

Bernard Shepard Leslie (1885-1957), retired engineer in the shoe-manufacturing industry, Beverly, Mass., died Feb. 14, 1957. Born, London, England, Dec. 2, 1885. Education, SB, Massachusetts Institute of Technology, 1908. Assoc-Mem. ASME, 1915; Mem. ASME, 1925. Mr. Bailey advanced from an apprentice to assistant to the vice-president of United Shoe Machinery Corporation in the years between 1909 and 1911. In 1916 he became president of the Krippendorf Kalculator Company. These early achievements are characteristic of Mr. Leslie's entire career.

Elmer C. Martin (1892-1957), consulting engineer and lawyer, Kansas City, Mo., died May 16, 1957. Born, Gerald, Mo., March 27, 1892. Parents, Caroline and J. W. Martin. Education, LLB, Cumberland University, 1933; attended Central Missouri Teachers College, and studied engineering accounting. Jun. ASME, 1917; Assoc-Mem. ASME, 1925; Mem. ASME, 1935. Mr. Martin was a specialist in utility accounting

(ASME News continued on page 916)

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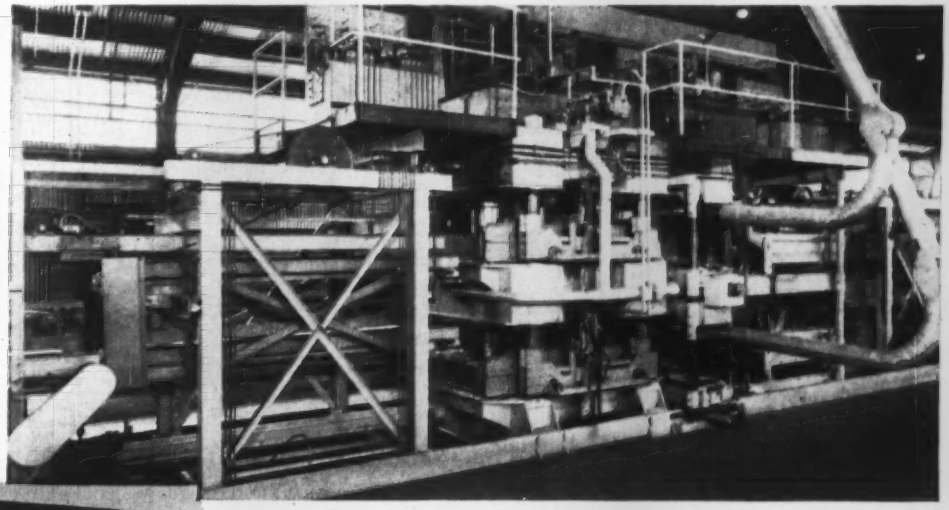
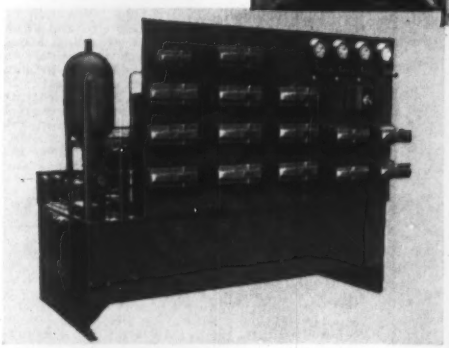


Prepress area of automatic hardboard plant designed and built as a package unit by the Industrial Development Company, Tacoma, Washington for Columbia Hardboard Company, Inc.

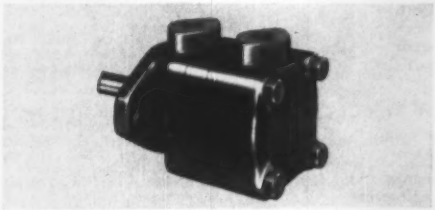
Reported to be the most highly automated in the wood products industry, this plant produces 60,000 sq ft of "Cedawood" per day (½" basis).

Seven Vickers Custom-Built Hydraulic Power Units play an important part in this performance; four are shown (in the photograph above) mounted on the platform directly above the prepress. The other three operate a series of automatic transfer systems in various parts of the plant. The transfer drives also use Vickers Vane Type Hydraulic Motors, which provide easily controlled variable speed for synchronizing various operations and for overload protection.

The use of hydraulic variable speed drives makes it easy to vary production rate, flakeboard thickness (⅛" to 1"), and type of product. Additional features are: accurate control, simplicity of installation, and low maintenance. For further information about the many benefits you get from Vickers Hydraulics, ask for Bulletin 55-67.



This Vickers Custom-Built Power Unit is individually designed to meet specific needs. It assures dependable performance, improves and simplifies design, reduces installation time and cost, and makes servicing easier. Write for Bulletin 52-45.



The performance-proven Vickers Balanced Vane Type Hydraulic Motor is an economical, efficient, and compact means of providing variable speed rotary power. It can be used for reversing service and can be stalled under load without damage. Write for Bulletin I&M-5103.

7834

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IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto and Montreal

and management. During World War I, he served in the U. S. Army.

Howard Cabe McCraw (1916-1957?), senior draftsman, Carbide and Carbon Chemical Company, Oak Ridge, Tenn., died recently according to information received by the Society. Born, Cowpens, S. C., March 5, 1916. Education, attended University of Tennessee, 1952. Mr. McCraw had been employed as a toolmaker before 1948 when he joined the Carbide and Carbon Chemical Company. During World War I, he served in the U. S. Army as an instructor in the theory, design, repair, and use of aerial gunnery equipment.

Keep Your ASME Records Up to Date

The ASME Secretary's Office depends on a master membership file to maintain contact with individual members. This file is referred to countless times every day as a source of information important to the Society and to the members involved. All other Society records are kept up to date by incorporating in them changes made in the master file.

The master file also indicates the Professional Divisions in which members have expressed an interest. Many Divisions issue newsletters, notices of conferences or meetings, and other material. You may express an interest in the Divisions (no more than three) from which you wish to receive any such information which might be published.

Your membership card includes key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you have expressed an interest. Consult the form on this page for the Divisions to which these letters pertain. If you should wish to change the Divisions you have previously indicated, please so notify the Secretary.

It is highly important to you and to the Society to be certain that our master file indicates your current mailing address, business or professional-affiliation address, and interests in up to three Professional Divisions.

Please complete the form, being sure to check whether you wish mail sent to your residence or office address, and mail it to ASME, 29 West 39th Street, New York 18, New York.

Please Print

ASME Master-File Information

Date

LAST NAME | FIRST NAME | MIDDLE NAME

POSITION TITLE | NATURE OF WORK DONE

e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.

NAME OF EMPLOYER (Give name in full) | Division, if any

*☐

EMPLOYER'S ADDRESS | City | Zone | State

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER: e.g. Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

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	Address changes effective when received prior to:
☐ Mechanical Engineering	10th of preceding month
☐ Transactions of the ASME	20th of preceding month
☐ *Journal of Applied Mechanics*	20th of preceding month
☐ *Applied Mechanics Reviews*	1st of preceding month

Professional Divisions in which I am interested (no more than *three*) are marked X.

- ☐ A—Aviation
- ☐ B—Applied Mechanics
- ☐ C—Management
- ☐ D—Materials Handling
- ☐ E—Oil and Gas Power
- ☐ F—Fuels
- ☐ G—Safety
- ☐ H—Hydraulics
- ☐ J—Metals Engineering
- ☐ K—Heat Transfer
- ☐ L—Process Industries
- ☐ M—Production Engineering
- ☐ N—Machine Design
- ☐ O—Lubrication
- ☐ P—Petroleum
- ☐ Q—Nuclear Engineering
- ☐ R—Railroad
- ☐ S—Power
- ☐ T—Textile
- ☐ U—Maintenance and Plant Engineering
- ☐ V—Gas Turbine Power
- ☐ W—Wood Industries
- ☐ Y—Rubber and Plastics
- ☐ Z—Instruments and Regulators

Maxwell Wallace Metzner (1891-1957), supervisor, test equipment design, General Electric Company, Erie, Pa., died early in May, 1957. Born, Erie, Pa., March 19, 1891. Parents, Orr Gail and Carrie (Firch) Metzner. Education, BS(EE), Case Institute of Technology, 1916. Married Katrina Jeanette Blass, 1918. Mem. ASME, 1944. Member Sigma Xi and Tau Beta Phi. Mr. Metzner had been a specialist in testing and testing equipment and the construction of complete testing departments. He had been a member also of the American Association for the Advancement of Science, and chairman of the Erie section of the American Institute of Electrical Engineers.

Henry Coddington Meyer (1870-1957), president, Meyer, Strong & Jones, Inc., New York, N. Y., died June 17, 1957. Born, Orange, N. J., Nov. 28, 1870. Parents, Henry Coddington and Charlotte English (Seaman) Meyer. Education, ME, Stevens Institute of Technology, 1892. Married Louise Griffin Underhill, 1896. Assoc. Mem. ASME, 1894; Mem. ASME, 1903. In the first decade of his career, Mr. Meyer was a member of the editorial staff of *The Engineering Record* which was founded by his father. In 1902 he opened an engineering office specializing in plans for mechanical and electrical equipment of buildings and power plants. In 1919, the firm expanded and Mr. Meyer assumed the position which he held at the time of his death. It was this firm which acted as consultant for a large number of buildings, including the Empire State, Cunard, and Standard Oil, and housing projects such as Parkchester. Surviving are his widow; a son, Henry C. Meyer, 3rd; and a daughter, Mrs. Emily Meyer Peters.

Floyd Ure Price (1884-1957), retired sales engineer, Dayton-Dowd Company, Detroit, Mich., died May 31, 1957. Born, Leesville, Ohio, Aug. 16, 1884. Parents, Orrin Holmes and Clara (Burr) Price. Education, Carnegie School of Technology. Married Roselia Griffith, 1919. Assoc. Mem. ASME, 1921; Mem. ASME, 1935. Survived by his widow; and a daughter, Mrs. Clara Mae Kirch, Pittsburgh, Pa.

Claude Dale Purves-Smith (1900-1957), consulting engineer, Consolidated Electrodynamics Corporation, and musician, Pasadena, Calif., died May 27, 1957. Born, St. Leonards, England, Aug. 9, 1900. Parents, George and Alice (Esom) Purves-Smith. Education, private tutors and Royal Air Force Officers Training College; studied engineering at California Institute of Technology. U. S. citizen, 1936. Married Josephine Swindall. Married 2nd, Winefrid D. Hine, 1942; two children, Theodore R. and Phyllis D. Purves-Smith, Honolulu, Hawaii. Mem. ASME, 1943. Mr. Purves-Smith was not only an engineer of note, but also a music teacher with an outstanding reputation on the west coast. In 1923 he had been director of the Peking Institute of Fine Arts, and made several tours as a concert pianist in the Far East. He had served the Society on a national and local level. In 1948-1949, he was on the executive committee for the San Francisco Bay area; in 1949, chairman and co-ordinator of all nontechnical activities for the ASME Semi-Annual Meeting. Since 1946, he has participated in the activities of the Machine Design Committee.

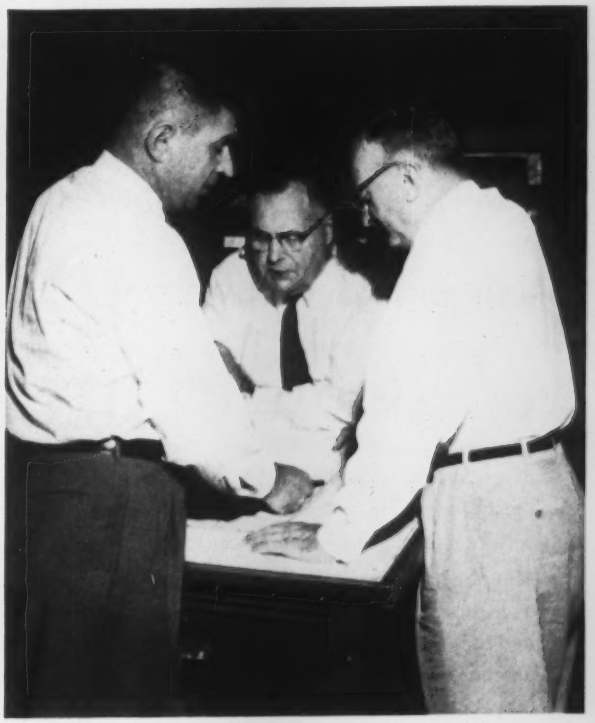
George R. S. Roome (1901-1957), assistant superintendent, Jersey Central Power & Light Company, South Amboy, N. J., died early in June, 1957. Born, Freehold, N. J., Aug. 30, 1901. Parents, John William and Marietta (Smock) Roome. Education, Brooklyn Polytechnic Institute, 1925. Married Eleanor Roome Gregory, 1931; two sons, Elwood Gregory and George William Roome. Assoc. Mem. ASME, 1944. Mr. Roome had been associated with the Jersey Central Power & Light Company since 1925. He was an associate member of the AIEE.

Everett Russell Sanborn (1913-1957?), whose death was recently reported to the Society, had been director, industrial engineering and labor relations, Amoskeag Lawrence Mills, Inc., Nashua, N. H. Born, Acton, Mass., June 10, 1913. Education, attended Harvard and Boston Universities. Mem. ASME, 1947. Registered engineer in the State of New Hampshire. Member also of the SAM and the National Association of Cost Accountants.

Frederic V. Wetherill (1895-1957), design engineer, Allied Chemical and Dye Company, Camden, N. J., died March 17, 1957. Born, Rosemont, Pa., Jan. 10, 1895. Parents, William Coolidge and Katherine Wetherill. Education, attended University of Pennsylvania; BS(ME), George Washington University, 1921; and Hays School of Combustion. Married Alice Nash, 1915. Assoc. Mem. ASME, 1919; Mem. ASME, 1930. Held patents on a recording planimeter, flow meters, and pipe flange gaskets. Author of a book entitled *Buoys and Buoys*; and a series of three articles on flow meters published in the technical press. Mr. Wetherill had been in the U. S. Navy, in the U. S. Lighthouse Service, and was with the U. S. Bureau of Standards.

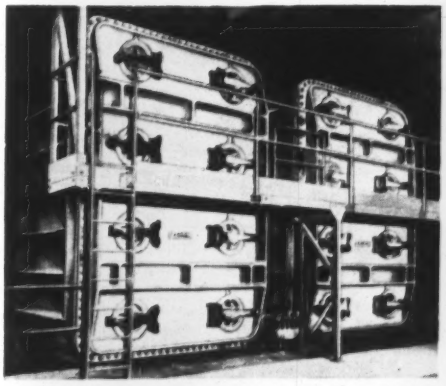
Before you place your next order...

It's saved many weeks, even months of engineering and executive time for scores of power companies! Basically, the idea is to shift as much of the work load as possible from the customer to C.H. Wheeler. By working this way, long conferences are replaced by short phone calls, and lengthy customer-prepared engineering specifications are supplanted by thumbnail performance sheets.

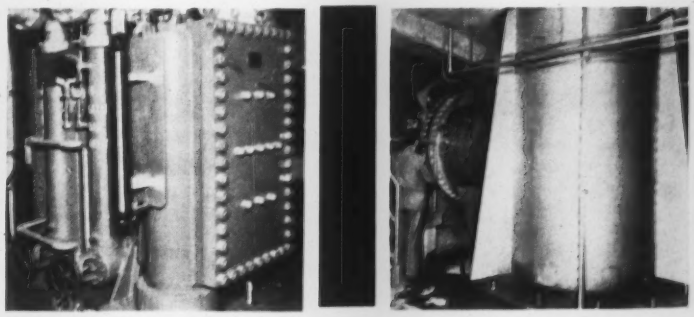


Since Wheeler specializes in designing and building condensing equipment, its Engineering Department is set up to take this bare minimum of data from the customer, and work up a comprehensive proposal from it alone. Here you see several department heads of C. H. Wheeler discussing engineering design prior to preparing a proposal for a C. H. Wheeler client.

Discover C. H. Wheeler's time-saving way to buy steam condensers



We often save clients up to 4 months' time by sending Wheeler engineers to work "on the board" at clients' offices, instead of mailing drawings for approval. Above is a typical installation—a 105,000 sq. ft. Dual Bank Divided Water Box Unit, installed at a New York station.* It condenses 950,000 lbs. steam/hr.



Other C. H. Wheeler power plant equipment includes steel-shell "Tubejet"® Air Ejectors (left) as installed at eastern plant*, Circulators (right) which in the same plant deliver 86,500 gpm water, and Condensate Pumps. See your representative or write for details on the time-saving way to buy Dual Bank Surface Condensers and other power equipment.

**Names of these and other power stations equipped by C.H. Wheeler supplied on request.*

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Manufacture of such products obviously demands absolute control over processing. To meet these critical requirements, equipment had to be selected with extreme care. For dependable control of pipelines which supply essential steam, water, air-conditioning, and other services, Jenkins Valves were prescribed.

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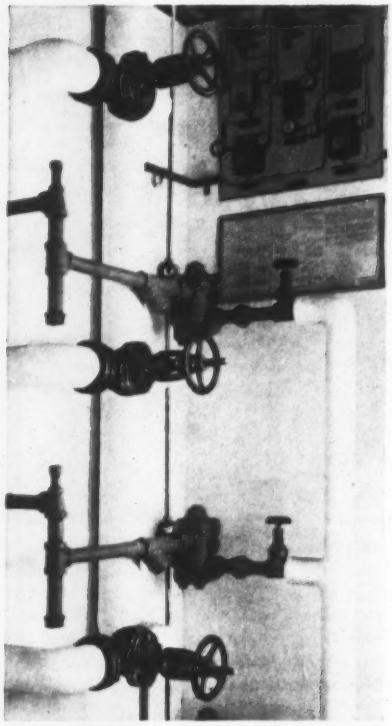
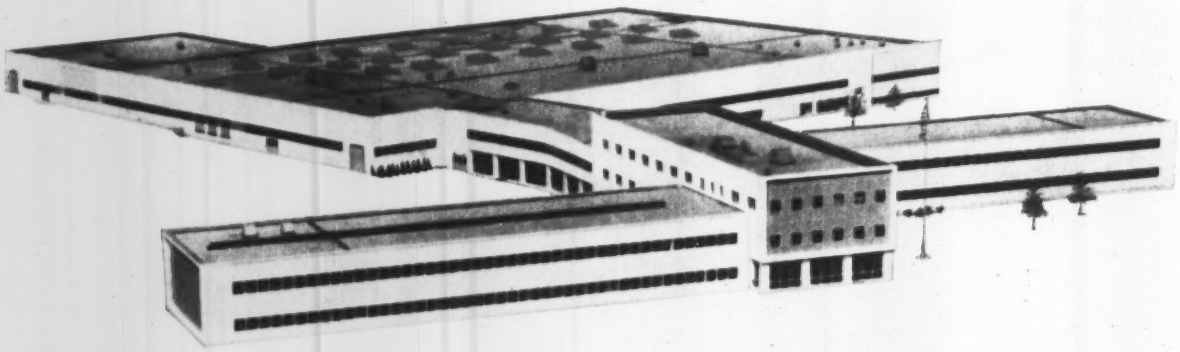


Jenkins Fig. 651-A iron body gate valves and Fig. 370 bronze gate valves on the air conditioning system.



Architects: SERGE P. PETROFF & ASSOCIATES
Mechanical Engineer: MUZZILLO & TIZIAN
Construction Engineer: NORMAN W. KEMPSON
Mechanical Contractor: RICHARDSON ENGINEERING COMPANY
General Contractor: JOHN W. RYAN CONSTRUCTION CO., INC.

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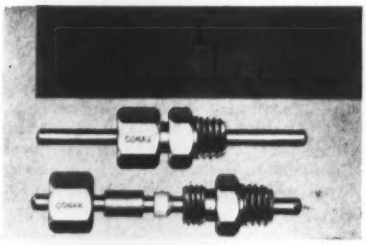
NEW EQUIPMENT

Centrifugal Pumps

A new line of high-speed, high-head centrifugal pumps for general water service has been announced by Gardner-Denver Co., Quincy, Ill.

The new model BH pumps are available in four sizes—a 1-in. model with capacities to 150 gpm; 1½-in. with capacities to 220 gpm; 2-in. with capacities to 440 gpm; 3-in. with capacities to 520 gpm.

The firm says the pumps feature stainless steel shafts, oil-lubricated heavy-duty ball bearings, mechanical seals, accurately contoured casings, and hydraulically balanced bronze impellers.



Packing Gland

A micro packing gland has been announced by Conax Corp., 2300 Walden Ave., Buffalo 25, N. Y., described in Bulletin 577.

The new gland is one of the smallest available to the industry, measuring only 21/32 in. long and 11/32 in. hex, the company states. It may be used to seal tubes of any material because the soft sealant makes it indifferent to tube composition, the firm reports. Increased fatigue strength and resistance to vibration is assured by reduction of stress concentration at the point of seal.

Glands with Teflon sealant have a temperature range from −90 to +500 F and seal pressures from .005 μ up to 1000 psi. Using Lava, sealant temperatures range from −300 to +1850 F with pressures from .005 μ to 3000 psi.

The standard bore sizes are 1/16 and 2/32 in. with 1/16 in. ips thread and nonstandard bore sizes ranging from .030 to .096 in. available upon request.

Bar, Tube Feeder

Nonstop production and automatic feeding from a conveyor line into a grinding machine is said to be provided by a special Model 1700B bar and tube feeder announced by Feedall, Inc., 38399 Pelton Rd., Willoughby, Ohio.

The new unit has a magazine loading feed with any desired constant rate of 5 to 20 fpm from the loader to the machine, the company reports. Parts are cycled either by photo-electric relay or mercury switch, actuated by the conveyor mounted on the out-feed conveyor. Cycling controls can also be operated by the magazine loader or the machine being fed.

The unit is entirely self-contained and is furnished ready to operate. It has a ¼ hp 3-phase motor and variable speed chain drive for conveyor.

Teflon-Faced Diaphragm

Hills-McCanna Co., 2433 W. Nelson St., Chicago, announces a new Teflon-faced diaphragm of one-piece construction for the firm's diaphragm valves.

The new diaphragm is made with a solid Teflon sheeting, permanently bonded to the face and external edges of an elastomeric backing to provide corrosion protection from both the internal flow and external atmospheric conditions. It also features the firm's sealing bead construction for positive closure under pressure or vacuum at operating temperatures ranging from −10 to 240 F and line pressures up to 150 psi.

Foil Strain Gages

Electronics and Instrumentation Div., Baldwin-Lima-Hamilton Corp., Dept. SO-86, Waltham, Mass., announces that its foil type SR-4 (bonded filament) strain gage is available in two new types designed to provide fatigue life, sensitivity, and hysteresis characteristics superior to those of nearest equivalent bonded-wire SR-4 strain gages.

Prior to these new gages, the firm reports, the foil type SR-4 strain gage was used mainly to measure strains at temperatures up to 1000 F or higher. In the room temperature range, up to 180 F, the earlier epoxy backed foil gages were inferior to bonded wire strain gages in performance, the company says. The new gages extend the useful room temperature range to 300 F for continuous duty, 400 F for short-time measurements.

According to the firm foil gages are thinner and more flexible and more easily applied than wire gages, especially in fillets.

Chart Drive Motors

Chart drive and two-phase balancing motors used principally in recorders, indicators and controllers have been redesigned by Minneapolis-Honeywell Industrial Div., Minneapolis, Minn.

The new design features a series of four die-cast aluminum housings bolted together into a square assembly, a printed circuit said to lengthen the life of coil connections, and felt wicks designed to prevent leakage of lubricating oils. One casting contains the stator, another the gear box, while two serve as retainers for bearings at each end of the rotor.

Any of the component parts can be inspected and serviced in a matter of a few minutes, according to the company. The products weigh 29 oz each.

Two-phase induction motor models have no-load shaft speeds of 330, 148, 44 and 22 rpm and maximum starting torques of 10, 20, 60 and 120 oz-in. Synchronous chart-drive motors have speeds of 180, 90, 60 and 30 rpm with pull-in torques ranging from 12 to 25.5 oz-in.

Molybdenum Tubing

Successful commercial extrusion of tubing made of molybdenum has been announced by Wolverine Tube, Div., Calumet & Hecla, Inc., 1411 Central Ave., Detroit 9, Mich.

The process, developed in cooperation with Climax Molybdenum Co., has resulted in tubing for evaluation purposes. Dimensions of the tubing are less than 1-in. outside diam; approximately 0.1 wall thickness; and 3–6 ft in length. Tensile strength is 70,000–100,000 psi and yield strength is 60,000–90,000 psi. These qualities make it particularly suitable for use in nuclear reactor heat exchangers, missile and rocket combustion chambers and for orifice tubing.

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KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Over-Running Clutches

Two lines of standard over-running Precisionspring clutches have been introduced by the Marquette Div., Curtiss-Wright Corp., 1145 Galewood Dr., Cleveland 10, Ohio.

One line consists of ball bearing clutches ranging from 20 to 3000 lb-ft torque capacity; the other line is made with sleeve or plain bearings in 8 lb-in. to 200 lb-in. torque capacity.

These standard clutches are suited for all over-running, indexing and backstopping applications, the company states.

When the clutch "takes hold", there is practically no movement of the spring on the surface it is gripping, it is stated. The spring and both units revolve as a solid unit. Since the clutch is self-adjusting, the driving torque is constant throughout the life of the clutch.

The clutches have only a few moving parts. The over-run is said to be very light or non-existent. In most applications, the original lubrication is the only lubrication required during the life of the clutch, the company says.

Reversible Air Motor

A reversible Model 6AM rotary air motor is available for original equipment or plant use in the $\frac{1}{2}$ to 2 hp range from Gast Mfg. Corp., Box 117N, Benton Harbor, Mich.

On applications such as pneumatic hoists or lifts, materials handling equipment, machine tool positioning or powering screw jacks, the reversible rotation feature is advantageous, the company states. Any four-way operating valve built for pressures below 100 psi may be inserted in the air supply line for instantly reversible motor control. Motor ports fit $\frac{3}{8}$ in. std pipe.

Models with single rotation, either right or left, are also offered and have similar dimensions and performance ratings. All models weigh about 17 lb, are explosion-proof and variable in speed from 300 to 2000 rpm on air line pressures from 30 to 90 psi. Mounting foot is std; muffler is included on nonreversible models only.

Hydraulic Pump

A large capacity variable delivery hydraulic pump has been developed by the Stratopower Div., New York Air Brake Co., Watertown, N. Y.

The pump, designated Model 64W1000 has a horsepower per pound ratio of 2.8, a ratio said by the company to be usually associated with small high speed pumps operating between 8000 and 10,000 rpm. The firm says it has been able to achieve this by designing a lightweight rotating group so that high rotational speeds up to 4500 rpm continuous duty are possible with this pump rated at 10 gpm at 1500 rpm.

The unit, which delivers more than 50 hydraulic horsepower is $9\frac{1}{8} \times 6\frac{1}{4}$ in. and weighs approximately 19 lb.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Outdoor Fork Truck

An outdoor truck of 20,000 lb capacity with dual drive tires has been added to the pneumatic-tire models in the Clarklift line of fork trucks produced by the Industrial Truck Div., Clark Equipment Co., Battle Creek, Mich.

Named the CY-200, the machine features 50-50 weight distribution, a planetary drive axle and 10.00 by 20 in. tires for driving power through mud and sand and over rough terrain. The unit has continuous follow-up type hydraulic power steering which operates throughout the engine speed range.

The steer axle is pivoted on two torsional rubber bushing assemblies to absorb shock and provide constant ground contact on uneven terrain, and 75 deg wheel angularity allows sharp turns.

A Hercules JXD six cylinder gas engine powers the CY-200. Engine power is transmitted by a torque converter and four speed power-shift transmission. Power brakes are standard. The unit will travel more than 20 mph loaded in both forward and reverse, and will climb a 22.7 per cent grade loaded, the company reports.

The hood opens from either side of the machine and may be removed by hand in a few seconds. Engine compartment side plates are spring clip mounted. The fuel filler cap is located outside the engine compartment.

An automatic tilt-lock valve in the hydraulic system prevents the upright from drifting when heavy loads are being tiered. The frame-mounted, telescopic upright is made from heavy section rolled channels.

Dimensions include: length, 187¾ in.; width, 96 in.; outside turning radius, 176 in., wheelbase, 130 in., and underclearance of 9 in. at the upright.

Ultrasonic Cleaner

Development of an ultrasonic cleaner with a self-contained filtering system, is announced by Vibro-Ceramics Div., Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

The Glennite U-102 circulating cleaner operates on a frequency of 40 to 44 kc, incorporates a forced air cooling system and has a cleaning tank capacity of one gallon. Only sudless detergents or chlorinated solvents are required, the firm states.

A circulating pump, permanent filter element and an additional tank for recirculating the fluid is designed to eliminate manually draining the tank and filtering the dirty fluid to render it reusable. The circulator automatically begins operating at the conclusion of the predetermined cleaning period.

The cleansing action which is achieved by cavitation produced by ultrasonic signals transmitted in liquid, will clean more rapidly and effectively using mild detergents than standard cleaning methods using strong cleaning agents, the company claims.

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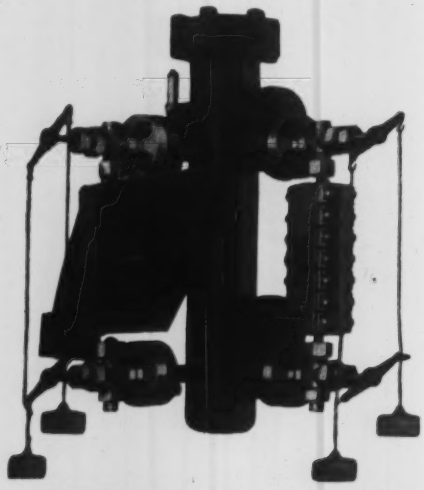

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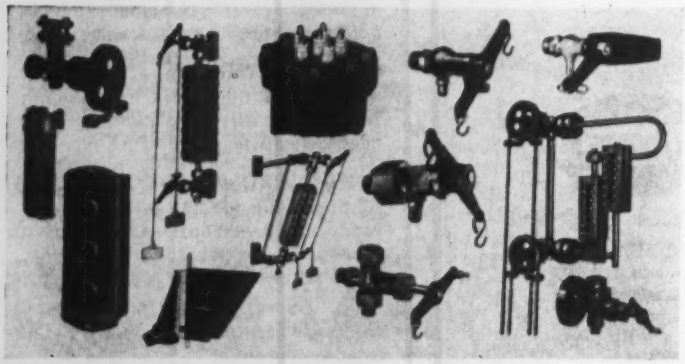

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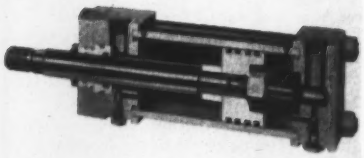
Thin-Wall Coil Forms

A new line of Mylar thin-wall coil forms has been developed by Precision Paper Tube Co., Dept. MXN, 2035 W. Charleston St., Chicago 44, Ill. Wall thicknesses of from .002 to .010 in. can be supplied.

The new tubes are highly resistant to moisture, solvents and chemicals and have higher dielectric strength than coil forms fabricated from other flexible insulating materials, the company reports. They are said to provide excellent thermal characteristics and the greatest tensile strength that any plastic film can afford. The company says the tubes will neither dry nor brittle with age.

The new coil forms are recommended by the firm for compact and miniature assemblies. For large work, where more rugged construction is desirable, the film is combined with or wound over conventional materials to improve their dielectric characteristics.



Hydraulic Cylinders

A new line of hydraulic cylinders, designated Series N, is announced by Hydro-Line Mfg. Co., 5600 Pike Rd., Rockford, Ill.

Standard cylinders in the line are available in bores ranging from $1\frac{1}{2}$ to 12 in. and rated for operation at 2000 psi and higher. All cylinders in the line meet JIC specifications.

All bore sizes are available in a choice of 13 standard mountings to meet varied installation requirements, with a number of additional variations of standard mounts obtainable. Assembly is said to be further simplified by the fact that the cylinders are available with a large external thread, a smaller external thread with shoulder, or an internal thread. Two wrench flats are normally provided, but rods with four or six flats are available for assembly in ordinarily inaccessible locations.

Two piston designs are available to suit the needs of specific applications. The majority of installations use a standard high-tensile cast iron, precision-machined, polished piston fitted with alloy step-cut rings. Where piston by-pass is not permitted, a flared-lip, heavy-web piston seal with back-up washers is used. Both piston types are piloted to the rod and held in place positively by means of a self-locking nut.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Reversible Locknut

Jacobson Nut Mfg. Corp., announces its plant in Kenilworth, N. J., is currently manufacturing a new low cost, reversible and reusable locknut. This new locknut, which is being marketed under the trade name of "Reverse-Lok," is a one-piece all metal locknut.

It has a 360-deg locking action, and is available in steel, brass, aluminum and stainless, in standard sizes.

Control Valves

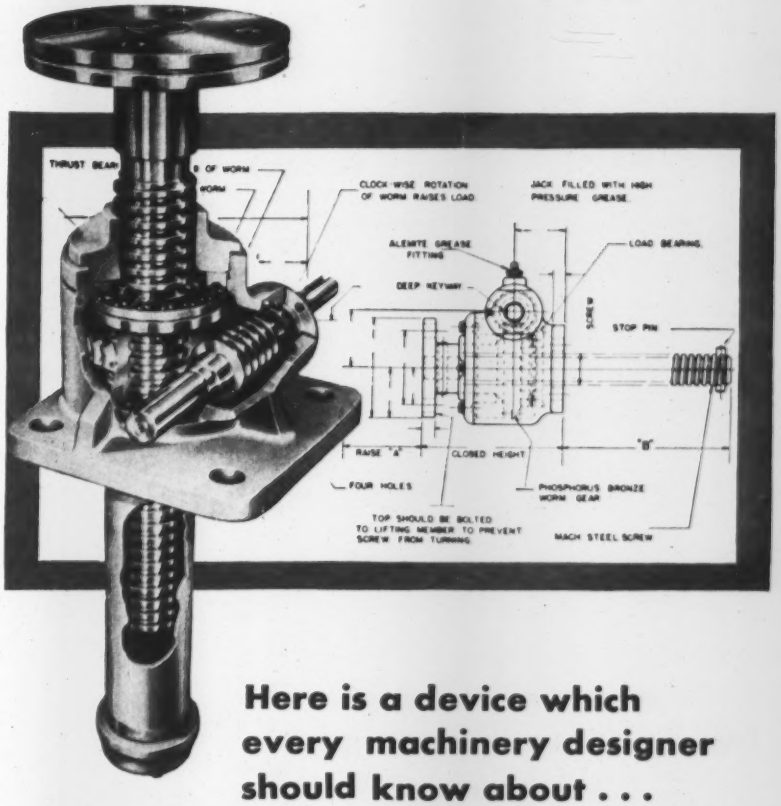
A new line of Speed King plug-in type 1/4 in. 4-way control valves fitted with built-in plugs and connectors, said to complete electrical connections automatically, is announced by Valvair Corp., 454 Morgan Ave., Akron, Ohio.

Available in both single and double solenoid types, for manifold or sub-base mounting, the new valves cut original installation and in-service maintenance time to a minimum, the manufacturer claims. Plug-in connectors built into pilot, valve body and manifold or sub-base complete electrical connections as components are bolted in place. Fixed connections to the machine's circuits, made in the manifold or sub-base at the time of original assembly, need never be disturbed, it is said.

Designed for control of smaller devices, the new 1/4 in. valves are reputed to afford compact size, extremely fast operating response, multi-million cycle dependability and low cost. The feature aluminum bodies, manifolds or sub-bases, end caps, spacers and pistons; hard chrome plated stainless steel stems; Fabreeka-backed stainless steel shock pads and standard O-ring packers. Solenoid pilots, built to JIC standards, are interchangeable between single and double solenoid types, and all the firm's standard valves. Coils, encased in molded epoxy resin, are guaranteed against burn-out for the life of the valve. Pilot plungers and valve stem are the only moving parts and no springs are used in the main valve body. Service life is reputed to exceed 25 million cycles.

Speed King 1/4 in. 4-way valves, for 30-250 psi air service, are available with solenoid coils for ac or dc, any voltage. Cylinder ports and inlet are tapped 1/4 in. NPT; exhaust is tapped 3/8 in. NPT. Port and mounting locations of single and double solenoid types are identical. Manual override for use during machine set-up is optional. The 1/4 in. 4-way valves, available for shipment from stock, are also offered in foot-mounted types.

Manifolds, with either 2 or 3 stations for multiple mounting, have 1/2 in. NPT common inlet and exhaust ports; 1/4 in. NPT cylinder ports for side or bottom connection; plus a 1 1/4 in. NPT common conduit port with full length side access cover. Manifolds may be ganged for multiple installation of any number of valves.



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Thousands of these jacks are in use on feeding tables, tube mills, welding positioners, pipe cut-off and threading machines, testing equipment, aircraft jigs, loading platforms, rolling mills, conveyor lines, arbor presses, and numerous other types of equipment. If you have a positioning problem, write for complete information, requesting bulletin AD-34-FF, which includes drawings and full specifications.

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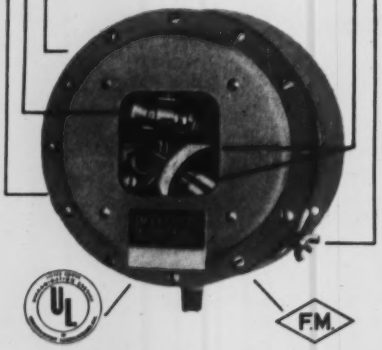

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Oil Cooled Motorpump

An oil cooled motorpump, now in quantity production for turbine powered air transports, is announced by Vickers Inc., Detroit 32, Mich.

Designed for continuous duty applications, new unit is claimed to offer a weight saving of approximately 25 per cent over the conventional air cooled motorpump. According to the firm, liquid cooling avoids duct work otherwise required to air cool the electric motor, thus providing additional savings in airframe space and weight. It is 20 in. long, motor diameter less than 4 in., and it weighs 31¼ lb. The 12 hp unit is rated at 2000 hr service.

A 400 cycle, 200 v electric motor drives a variable displacement piston type pump, an integral centrifugal boost pump for cooling circulation and piston pump supercharging. The motorpump delivers up to 8 gpm at 2250 psi and reduces to 6 gpm at 2950 psi. At 3000 psi, flow is zero. These flow and pressure combinations, 8 to 6 gpm range, provide constant horsepower for a variety of flight operating conditions, the company says.

Tube Cutter

A machine designed to speed up precision cutting of tubing made of steel, copper, aluminum and other metals, has been placed on the market by Novi Tool & Machine Co., 25806 Novi Rd., Novi, Mich.

According to the company, the machine can be used to cut off tubing of any diameter from ⅛ in. with a maximum wall thickness of 0.028 in. to tubing of ½ in. diameter with a maximum wall thickness of .045 in. The set-up can be easily changed from one diameter tubing to another, it is stated.

Tubing can be cut off to any predetermined length. For lengths from 2 to 30 in. the tubing is cut with the bed of the machine tiled backward, allowing parts to fall into pans. When cutting off longer tubing, the machine can be set level to line up with table or bench, eliminating the bending of tubing. After cut-off, the tubing can be flared without burring.

Shaft Mounted Drive

A new higher ratio of 24:1 (or 20:1 in 2 smaller sizes) has been added to the line of all-steel, double reduction, shaft mounted drives, manufactured by Falk Corp., Dept. 255, 3001 W. Canal St., Milwaukee 1, Wis.

The outside dimensions and torque rating remain the same. Practical advantages attributed by the company to the higher ratio units include the use of smaller sheaves to obtain a given output speed, and a saving in motor cost when, because of the lower output speed, a 1750 rpm motor can be used instead of a more expensive slower speed motor.

Units are available for horizontal and vertical application, in ½ to 30 hp ranges, with output speeds as low as 5 rpm.

O-Ring Compound

A precision compound has been developed by Precision Rubber Products Corp., Dayton, Ohio, for O-ring seals in the automobile and aircraft industries.

According to the firm, premium and standard grade gasolines developed for high compression engines contain both aromatics and other additives which have a deleterious effect upon O-rings and other synthetic rubber parts. The new compound, 119-70, was designed to meet these new needs and fills the seal requirement in valves, fuel line couplings and carburetors, the company states. It has extraordinary resistance to the gases, oils and gasolines required by Underwriters Laboratories testing procedures, the firm reports, and it will not swell abnormally, nor will it deteriorate in present engine fuels.

The compound is said to have been found to be highly effective for use in high temperature service in aircraft di-ester base synthetic lubricating fluids. The material has been approved by the Underwriters Laboratories (Card No. MH 6154, Guide No. 143 A15, dated Jan. 21, 1957) for service with gasolines of all types and for fuel oils including the No. 6 grade. It is also approved for use with propane, butane and the usual low pressure home fuel gases.

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BUSINESS NOTES
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Pneumatic Power Unit

Lear, Inc., 110 Ionia Ave., Grand Rapids 2, Mich., has announced a new pneumatic power unit said to operate in temperatures far above the tolerance range of known hydraulic or electrical systems.

The new device develops exceptionally high torque at relatively low speeds, according to company engineers, and does not disintegrate under overspeed conditions. It offers a power source for such applications as thrust reversers, accessory drives, actuation of air inlet and nozzle-positioning systems, and reactor-rod positioning.

The unit may be used as a power unit for remotely-located screwjacks of linear actuators and is adaptable to a wide range of actuation methods, the firm reports. Wide application potential in many auxiliary-drive systems is predicted by the manufacturer.

An exceptionally high torque-to-inertia ratio allows the units to follow electronic modulation and to deliver virtually instantaneous starts and stops. One model reportedly accelerates from zero to 100 rpm in one twenty-five-thousandth (0.00004) of a second, operating under 30 psig of applied air pressure against an opposing force of 20 lb-in. Units are instantaneously reversible and are equally efficient in either direction, it is claimed.

Torque of the air motor is proportional to gage pressure of the air, and is virtually unresponsive to temperature changes. The units provide a constant performance output.

The positive-displacement, pressure-relief devices exhibit low leakage rates and required control forces are extremely low.

The devices are controlled by an external signal which drives a fully-balanced, center-fed, four-way pneumatic barrel valve. Rotation of the valve pressurizes the motor for either clockwise or counterclockwise rotation. Overcoast is sharply limited by the dynamic braking which results when the control valve is moved to the center "off" position. Under these conditions, the air motors function as a vacuum pump on the inlet side and a compressor on the exhaust side.

Materials are high-temperature magnesium alloys, stainless steels, and stellites, matched to eliminate problems of differential expansion. Motor gears are radially mounted and axially positioned by pivot balls. Ball-mounting of the barrel of the valve and of the control shaft reduces friction and increases positioning accuracy.

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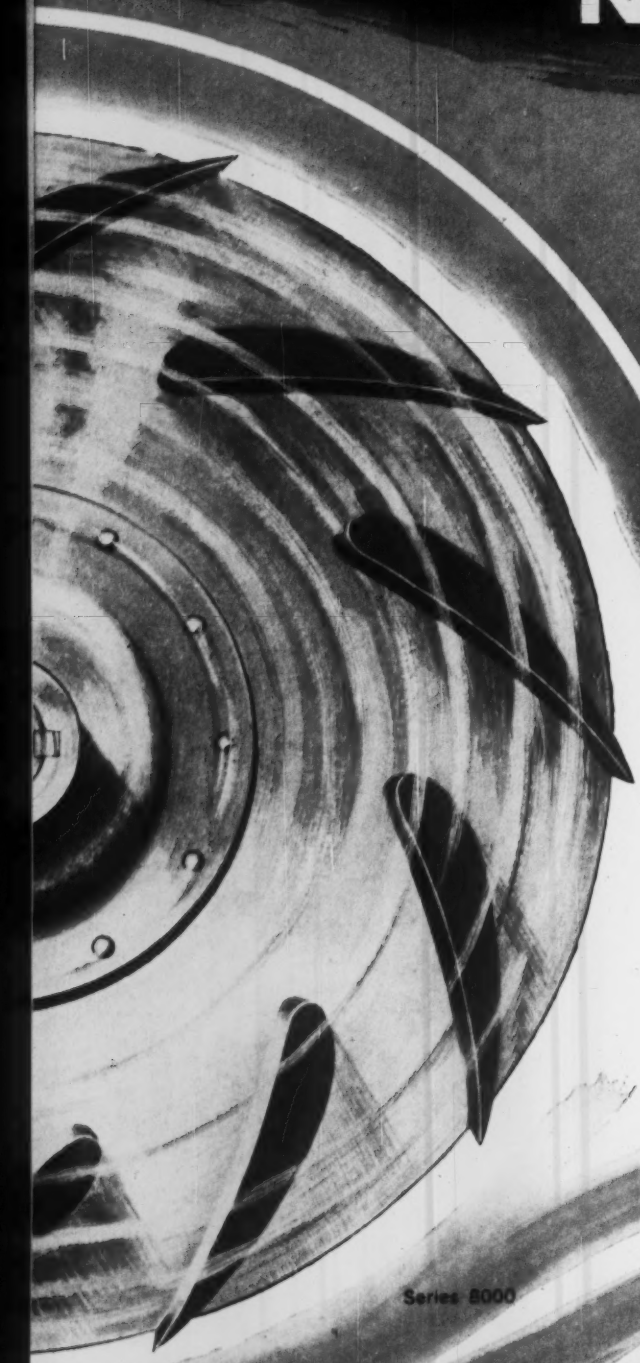

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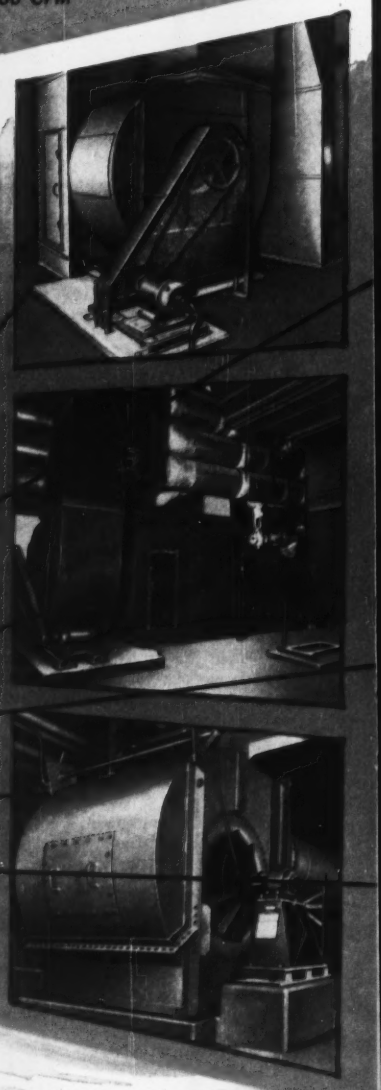

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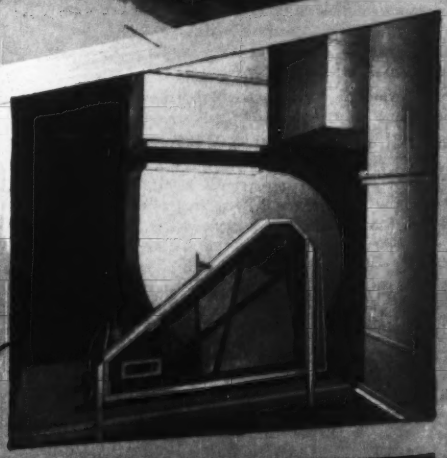

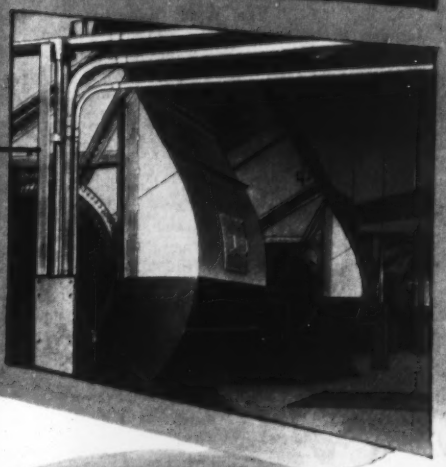

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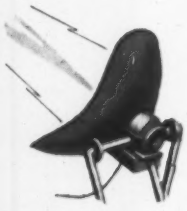

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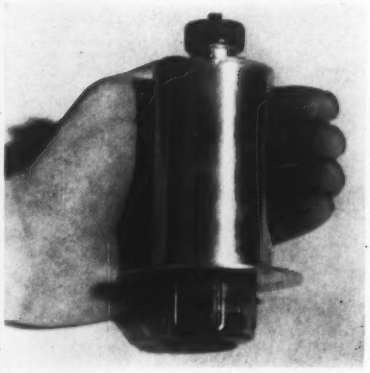
Conveyor Chain

Forged steel conveyor chain, each link made with a wing attachment, has been announced by Robert A. Main & Sons, Inc., 257 Pascack Rd., Paramus, N. J.

The new pin type chain is manufactured for maximum strength conditions and will stand extra hard wear and shock, the company states. It can be furnished for acid or heat conditions using corrosion or heat resistant materials.

Each pin is locked against rotation, and each link has a wing attachment to make it easy to attach wood or metal conveyor slats, the company says. It can be used in single or multiple strands. Due to its uniform size, links need not be matched and it is available in standard pitches. Sprockets and complete conveyor aprons can be supplied.



Variable Timer

Patterson, Moos Div., Universal Winding Co., Inc., 90-28 Van Wyck Expressway, Jamaica 18, N. Y., has developed a variable timer that provides for a settable time delay between .3 and 10 sec with an accuracy of ±5 per cent.

Called PM-47, the timer provides an output energy in excess of 35,000 ergs. Temperature ambients from −70 to +165 F and accelerations up to 100 g's have no effect on its operation, the company says. The electric timer is said to be suitable for use in missile systems and airborne applications, pilot escape systems, sled timers, programming devices and explosive element initiation.

Transient circuits are used to achieve the time delay, which is furnished by components of the weapon approved nonpower consuming type. No tube filament power is required. The selected time delay between 0.3 and 10 sec is achieved by applying between 100 and 400 v (depending on the time delay desired) to the device. The time delay is initiated by the release of a pull wire which allows a spring driven plunger to complete the necessary switching action. At the close of the time delay period a pulse of electrical energy in excess of 35,000 ergs is applied to the load.

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NEW EQUIPMENT
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Precision Switch

A heavy duty, snap-action switch, able to handle up to 2 hp, is available from Acro Div., Robertshaw-Fulton Controls Co., Columbus, Ohio.

The new switch, called Duo-Snap, comes in four different terminal and circuit arrangements, permitting at least six circuit variations. Its snap-action is achieved through the rolling spring principle.

It is 2 in. in length and it possesses a high electrical rating: 2 hp, 230 v a-c; 1 hp, 150 v a-c; and for pilot duty, 20 amp, 250 v a-c.

Circular Coil Condensers

A new line of circular coil aircooled condensers engineered-designed for maximum heat transfer efficiency has been announced by Trane Co., La Crosse, Wis.

The new dry type condensers use no water or sprays to condense refrigerant. Only outside air induced through the unit's circular coil is used for condensing purposes. This makes the air-cooled condensers ideal for application in areas where water is scarce or where local ordinances restrict use of water for cooling, the company states.

Designed for installation out of-doors for remote connection to the air conditioning unit inside, the units are available in three standard sizes. They are used singly with 3, 5, and $7\frac{1}{2}$ hp package type air conditioners, and in multiple combinations with larger horsepower conditioner equipment.

Relay Pilot Valve

A new high-capacity relay pilot valve said to convert any high grade commercial cylinder to a double-acting power position is now in production at the Orrville, Ohio, plant of Hagan Chemicals & Controls, Inc., Pittsburgh, Pa.

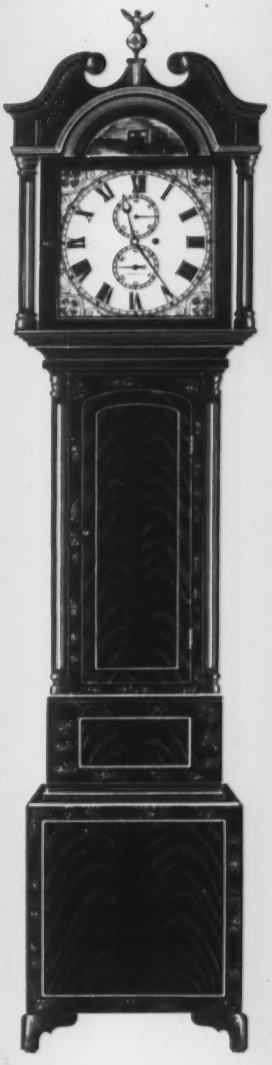
Designated the remote mounted positioner, the unit converts input air signals to pneumatic or hydraulic signals up to 150 psig for actuating power pistons, diaphragm motors and rotary vanes. Standard input signal range is 0 to 30 psig.

The positioner is said to be particularly adaptable for use with power pistons since it enables the user to choose the most desirable power cylinder from the standpoint of bore, stroke, and style of mounting.

According to the company, a conventional application is the positioning of large butterfly valves in response to signals from a remote control point. The air signal acts on a diaphragm in the positioner, displacing the small servo valve and sending air or hydraulic pressure to either end of the power cylinder. This, in turn, actuates the butterfly valve.

The same motion is transmitted through follow-up linkage to the positioner cam, returning the servo valve to null position when the butterfly valve reaches the position corresponding to the air signal value.

19,862 years of precision metal-forming



When you specify FLEXON® Expansion Joints, you actually *buy time*—19,862 years of combined experience in the team of engineers, metallurgists, and technicians who produce Flexon Expansion Joints!

And all this time has been invested in perfecting formed and corrugated tubular shapes in metal, made with watch-like precision—flexible metal hose, instrument-type bellows, "impossible" bends and section modulations for aircraft parts . . . **and expansion joints of every kind.**

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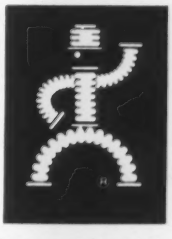
Write today for your copy of the Flexon Expansion Joint Design Guide—28 pages of facts about absorbing pipe motion.

EJ-210



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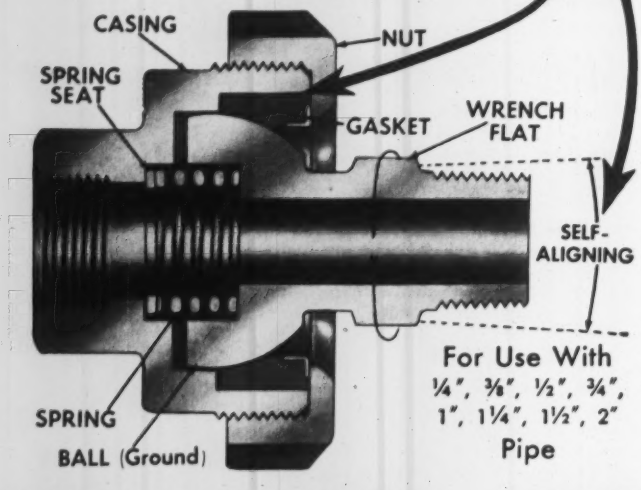
TWO BIG ADVANTAGES!

1. Self-Aligning Ball
2. Chemically Inert Seal



BARCO SWIVEL JOINTS

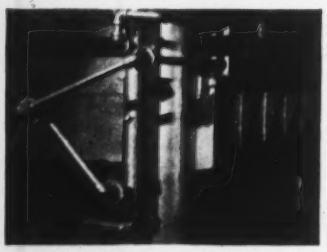
for STEAM, OIL or WATER LINES

Two important features give Barco Swivel Joints capabilities not found in ordinary swivel joints:

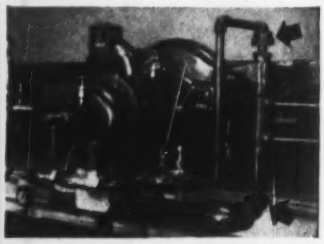
SELF-ALIGNING—Provides a wide tolerance for pipe fitting and machine alignment. Saves endless hours installation time and permanently protects against binding and wear.

CHEMICALLY INERT SEAL—Pressure sealing and automatically self-adjusting for wear. Ideal for steam service. Uniform performance over temperature range from −50° to +600°F. No lubrication needed.

Send for Catalog 265B, "Barco Self-Aligning Swivel Joints." Ratings as high as 750 psi steam or 3000 psi hydraulic. Sizes ¼" to 2"; angle or straight. *Ask for recommendations—Barco is at your service.*



PLATEN PRESS—Barco Swivel Joints (see arrows) in "dog leg" piping provide flexible connection to moving platen of press. Platen moves up and down. Line handles steam and cold water alternately.



OIL BURNER—Two Barco Swivel Joints (see arrows) mounted as pivot points on hinge provide swivel connections for fuel oil and steam atomizing lines to door mounted oil burner.

FOUNDED 1900 BARCO PRODUCTS BACKED BY EXPERIENCE

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The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints
In Canada: The Holden Co., Ltd., Montreal

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Hydraulic Presses

Multiple hydraulic presses, using only one operator and taking their power from the shop airline to mold rubber, plastic or ceramic, are announced by Allied Engineering and Production Corp., 2421 Blanding Ave., Alameda, Calif.

The presses are single, double, triple or quadruple. Each section has a capacity of 50 tons. Platens are 13 × 13 in. Maximum operating for each is 5000 psi. Temperature range is 150 to 550 F with or without heated platens. Ramstrokes and daylight openings are 13 in.

Rubber Bumper

The Castle Rubber Co., Box 589, East Butler, Pa., is marketing a new type of rubber bumper block called the Cushioneer. It is primarily designed for materials handling facilities and equipment such as loading and receiving docks and truck frames, the firm reports.

The main function of the bumper is to protect equipment and merchandise in transit from the damaging effect of vehicle contact. It is manufactured in two styles: bonded to a steel plate for welding attachment, or unbonded for bolt attachment. Several standard sizes are available.

VISCOSITY OF LUBRICANTS UNDER PRESSURE

This Report reviews twelve experimental investigations made in England, Germany, Japan, Russia, and the United States on 148 lubricants comprising 25 fatty oils, 94 petroleum oils, 17 compounded oils, and 12 other lubricants. Data collected are co-ordinated by means of sixty tables in which the results originally appearing in diversified units are compared. The methods proposed for correlating viscosity-pressure characteristics of oils with properties determined at atmospheric pressures are reviewed and illustrated. Pertinent topics such as experimental work on heavily loaded bearings, lubrication calculations, and additional techniques for viscosity are covered. Conclusions and recommendations are presented. Other sections give the required computation of temperature and pressure coefficients, a bibliography of 189 items, and symbols.

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Gas Control Unit

The availability of a new, low cost industrial gas chromatograph control unit and analyzer section for the continuous analysis of as many as four components of a specific gas stream, is announced by Process Instruments Div., Beckman Instruments, Inc., 2500 Fullerton Rd., Fullerton, Calif.

The chromatograph, designated Model 120A, features two distinct instruments which can be placed as much as 1500 ft apart yet maintain accurate measuring and recording, the firm says. The chromatograph features simplified control, visual and permanent recorder readout, an accuracy of ±1 per cent, a locking door, an integrated test circuit to facilitate periodic maintenance without disassembly, and automatic or manual operation.

Measuring $11^{3}/_{8} \times 19^{1}/_{8} \times 15^{1}/_{8}$ in. and weighing 60 lb, the Series 120 chromatograph records measurements made by the firm's new analyzer Series A developed for use in Class I, Group D, locations. It features ± .2 C temperature control for operation up to 110 C and provision for true split column operation allowing complete analysis of up to four high and/or low boiling point components in a single stream. A single action five-way linear sample injection valve which duplicates the action of five conventional two-way valves is the heart of the gas handling system.

Dust Collector

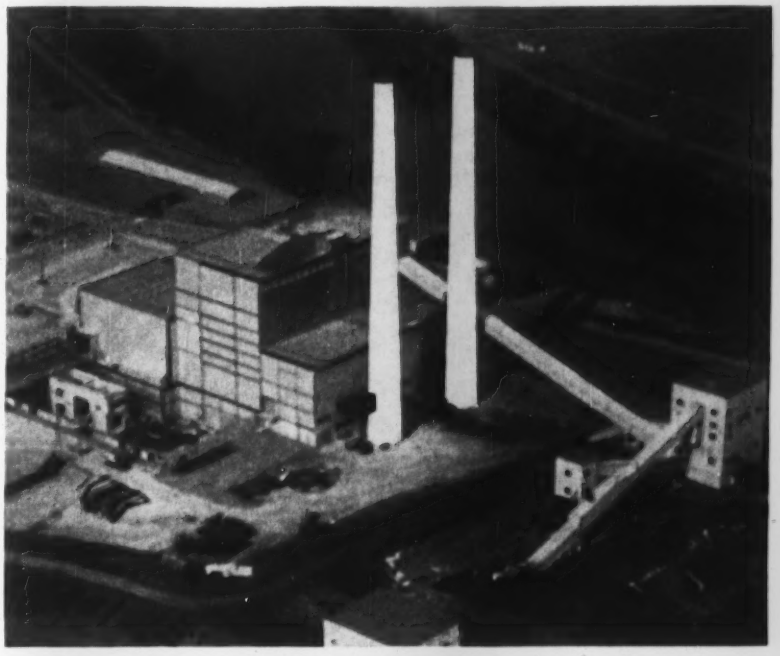
Hagan Chemicals and Controls, Inc., 323 Fourth Ave., Pittsburgh, Pa., is now manufacturing a centrifugal dust collector the company claims has the highest efficiency and lowest erosion rate of any mechanical dust collector on the market.

The collector has had success in the elimination of fly ash from coal-fired steam boilers in steel mill-power plants, the company states, adding that collection efficiencies range as high as 97 per cent in some installations.

The firm attributes the efficiency of the collector to a unique design of the venturi-spiral vaned nozzles at the inlet of each separating tube. This design effects an almost instantaneous six to one increase in gas velocity, greatly intensifying the tangential or outward thrust characteristics of the centrifugal action, it is stated. Even the most minute particles, five microns and under, are ejected and collected.

The company claims the venturi-spiral vane design is the only one that produces an even flow distribution over the entire inlet nozzle area, eliminating critical areas of wear.

Another feature singled out is the strong welded facing formed by the individual hexagonal inlet nozzles. The firm says that since each inlet nozzle butts snugly against the others on all six sides, there are no flat waste areas to encourage dust deposits that eventually lead to plugged tubes and vanes.



a second CONSOLIDATED Chimney

. . . the result of operating experience with the first . . .

Northern States Power Co., Minneapolis, Minn., contracted for their first Consolidated chimney in 1932 when the Black Dog Station was erected to meet the constantly increasing demand for power. It is a 292 ft. by 11 ft. tapering concrete chimney with acid proof brick lining and it was so well designed and so carefully built that it has continued to give excellent service through these years.

It was but natural, therefore, that when continually increasing demand required the installation of additional boilers that Consolidated should again be commissioned to erect an exact duplicate of the original chimney.

Consolidated is proud of this installation and of the many other chimneys it has designed and erected in its quarter-century of service to the industrial leaders of America—companies that are familiar to everyone* and whose standards are known to every consulting engineer, architect and general contractor. Designed by men who know their business, erected with painstaking care to exact specifications, Consolidated chimneys give performance and service year in and year out to meet the most exacting requirements.

Consolidated designs and builds chimneys of all types and all sizes—Perforated Radial Brick, Tapering Reinforced Concrete, Face and Common Brick, Acid Proof, High Temperature; installs linings for steel stacks, waterproofs, repairs and rebuilds, installs lightning rods and aircraft warnings; demolishes chimneys. Whatever your chimney problem may be, Consolidated has the experience, the knowledge and the skilled personnel to handle it.

Phone, wire or write today *for information. Ask for catalog giving installations, engineering service, chimney design data and specifications.*

*Gladly supplied upon request.

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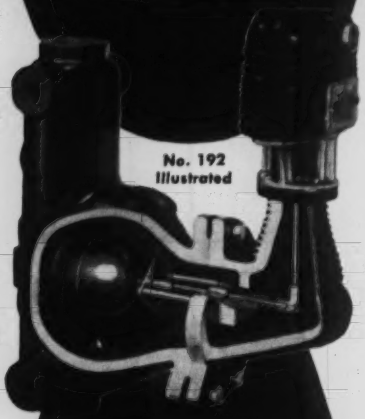

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92 SERIES
Pump Control, Cut-Off and Alarm Switch
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Here's a whole new concept of control design and performance . . . with the best-known name in its field. Introduces repulsion magnetic switching for positive opening and closing. Beats the heat as never before . . . okayed for 75° C. (167° F.) wiring. Has extra generous float clearances, operating levels that are not affected by pressure changes, and a host of other refinements.

Write for Bulletin L-123

Shows 92 Series models with or without integral water column. Has full engineering data for controlling pumps or electric valves on boiler or tanks, for low water cutoff and alarm, etc.
Also shows companion 91 Series for pressures to 150 psi.

McDONNELL & MILLER, INC.
3510 N. Spaulding Ave., Chicago 18, Ill.

McDONNELL
Boiler Water Level Control

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Pilot Relief Valve

Instant reaction, clog-free operation and silence are claimed to have been incorporated in a new low priced pilot operated relief valve introduced by Webster Electric Co., Racine, Wis. According to the firm, the new valve is in answer to problems created by brute-force type relief valves in the hydraulic lift field especially. The new valve is said to allow about 40 per cent more work output than the average brute-force type.

The new relief valve is adjustable from 500 to 2000 psi and has a maximum capacity of 20 gpm. The valve is unusually silent when in operation.

Industrial Elbow Fittings

Hose elbow fittings said to simplify hose installation in confined spaces and reduce the number of joints and fittings required have been developed by Aeroquip Corp., Jackson, Mich.

According to the company, chief advantages of the new fittings are less flow restriction, greater space-saving, and reusability of the fittings. By reducing the number of joints in an installation, possible points of leakage are also eliminated, the firm states.

The fittings are fabricated from formed tubing and are available in swivel nut ends with JIC and SAE threads. Mating adapters are also supplied for straight gasket seal and pipe threads. All parts are steel.

They are manufactured in 45 and 90 deg configurations, and are designed for use with the company's medium and high pressure hose. Both short and extended length elbows are available. The swivel fittings tighten without twisting the assembly, and assemblies with double elbow fittings may be angled to the positioning required by the installation, the company says.

Package Control System

A. W. Cash Co., Decatur, Ill., in conjunction with Sparton Corp., Jackson, Mich., has developed what is claimed to be the first package control system for remote positioning of cone, butterfly, plug and ball valves; sliding stem valves; such variable speed mechanisms as throttles and rheostats.

Designated as the Series 300 packaged control system, it can control pressure, flow, surge, liquid level, proportioning, speed, and other process variables at distances of a few feet to many miles with one operator at one central location. It is recommended by the companies for such uses as municipal water distribution, sewerage treatment, petroleum and chemical processing, atomic energy and other hazardous operations.

The system, which combines the response speed of electronics with the smoothness of pneumatics and hydraulics, utilizes a power supply, positioner, reducing valves, and booster valve as standard components in a single package, which receives its signals from the remotely located supervisory control unit via telegraph, telephone or private wires, or microwave transmission.

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TORQUE TESTING FIXTURE

FOR TESTING Screws, thread-cutting and thread-forming screws—all types of threaded fasteners; threaded parts and threaded connections.

FOR MANUFACTURERS
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in assembly.

Capacities: (0-200 in. lbs.) or (0-150 ft. lbs.)

Write for Bulletin TTF

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You know those rare days when *everything's* right? Air smells good. Food tastes terrific. Even the old face looks good in the mirror. *Today* can be that kind of day. Just do two things. Call your doctor for a thorough medical checkup for cancer. Then write out a check—a nice fat one—to the American Cancer Society, and mail it to "Cancer" in care of your local Post Office.
AMERICAN CANCER SOCIETY

KEEP INFORMED

NEW EQUIPMENT
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Line Index Machine

A new line-index type machine is announced by Snyder Tool & Engineering Co., 3400 E. Lafayette, Detroit 7, Mich.

The unit is claimed to perform up to 40 drilling, boring, turning and tapping operations to complete the machining of three different large tractor drive axle housings. The housings are made of either malleable iron or cast steel. One housing is produced at a net rate of 9.1 pieces per day, the second at 10.2 parts per day and the third at a net rate of 8.5 parts per day, the company reports.

Flexibility of machine operation is provided by mounting the part in a fixture with a built-in index table. This fixture and table unit is indexed in a line to six stations between a pair of opposed wing-base machining units. Where required, the fixture is rotated 180 deg between stations.

The first pair of machining units that operate in stations one and two consist of a two-spindle boring head and an opposite single-spindle cross facing head. The second pair of machining units, portions of which operate in stations four through six, consist of a 31-spindle drill head and an opposite 25-spindle tapping head.

The 40 separate machining operations are accomplished by pushbutton controls that index the fixture back and forth between the stations, rotate the fixture in accordance with a program sheet and cycle the machining heads. Quick change adapters in certain spindles facilitate the 28 tool changes that are made to complete the machining of the part.

The machine is hydraulically operated and electrically controlled. The machining units are the firm's standard way-types that are provided with automatic lubricating systems. Separate hydraulic power packs provide power for operating the machine slide and index motions.

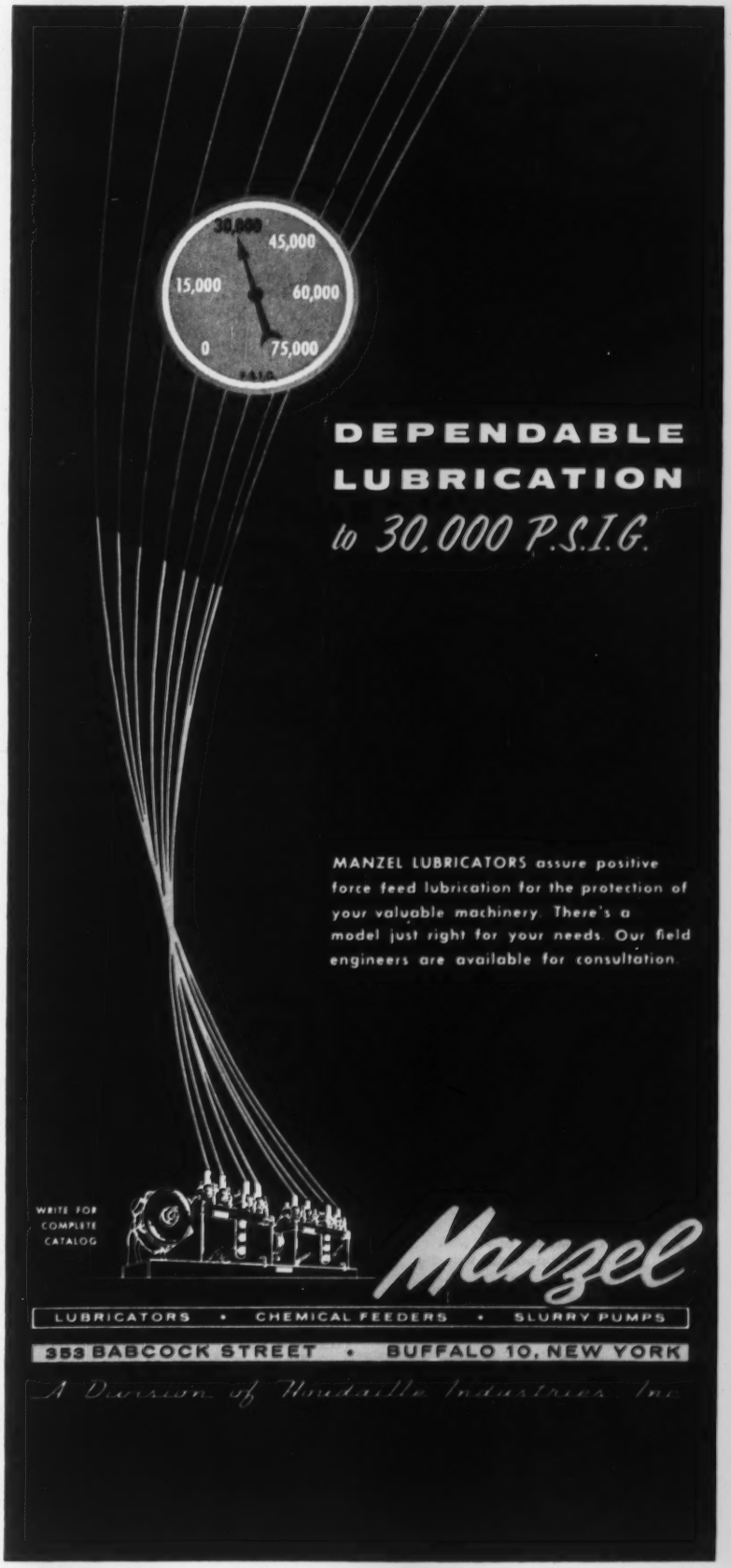
All machining units have hardened and ground ways. The tapping head has individual, automatically-lubricated, leadscrew drives for each spindle. The heads are driven by $7\frac{1}{2}$, 10, 15 and 20-hp motors.

Accessibility for tool changes is provided by building the machine in the form of two machining sections, each having a pair of opposed machining units. The center portions of the sections are bolted together.

All-Plastic Valves

Valcor Engineering Corp., Kenilworth, N. J. announces the development of an all-plastic solenoid valve series to handle caustics, acids and highly corrosive media.

A feature of the valves, known as the SV-5100 series, is that there is no metal contact with the media being handled. They also feature bubble-tight seal of a construction that gives them unusually long life under extreme conditions, the company claims. No fittings are required and the valves will operate in any position.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Future maintenance costs and shutdowns are eliminated when you install Thomas Flexible Couplings. These all-metal couplings are open for inspection while running.

They will protect your equipment and extend the life of your machines.

Properly installed and operated within rated conditions, Thomas Flexible Couplings should last a lifetime.

UNDER LOAD and MISALIGNMENT ONLY THOMAS FLEXIBLE COUPLINGS OFFER ALL THESE ADVANTAGES.

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2 Free End Float
3 Smooth Continuous Drive with Constant Rotational Velocity
4 Visual Inspection While in Operation
5 Original Balance for Life
6 No Lubrication
7 No Wearing Parts
8 No Maintenance

Write for Engineering Catalog 51A

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

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Ultrasonic Generator

Branson Ultrasonic Corp., Stamford, Conn., has introduced a new size generator in its line of ultrasonic cleaning devices.

The Sonogen model AP-25-B was designed for use with standard tank-type or all-welded stainless steel immersible transducers. It is recommended by the company for unattended and quick cleaning of small parts, such as watch mechanisms, jewelry, instruments, transistors and other electronic units, anti-friction bearings, and components that must be dirt-free before assembly.

For cleaning-rinsing or other two-step operations, the generator output can be switched easily between transducers mounted in separate tanks.

Rated r-f output of the 10 × 16 × 12-in. deep generator is 125 w average power, with peak power on pulses of 500 w.

Sound Deadener

A nonflammable, nontoxic, nonexplosive, odorless and stable deadener has been introduced by The Philip Carey Mfg. Co., Lockland, Ohio.

The product, Number 42 deadener, is for use on steel surfaces as a sound and vibration deadener and anti-corrosive coating. According to the company, the material can be used any place where there is a problem of metal-produced noise.

The deadener has a uniform high flow rate at temperatures 40 to 70 F; requires low pump and atomization pressures; is lump free and nonsettling; has a low curing time at variable oven temperatures; and dries without blistering, sagging or drop-off, the company states.

Aluminum Alloy

Aluminum Company of America, 797 Alcoa Bldg., Pittsburgh 19, Pa. announces alloy 5456, a new composition being rolled into plates and said to have the highest mechanical properties available in the non-heat-treatable alloys.

According to the company, it meets U. S. Navy needs for greater strength in aluminum plate for gun mounts, carrier elevators, deckhouses and other shipboard installations. The plate also is suited for overhead traveling cranes, ship unloaders and other similar heavy duty structures.

Good resistance to corrosion and stress corrosion, plus high strength, are offered by the alloy, the firm states. It also possesses excellent welding characteristics and can be joined by the resistance, tungsten arc and consumable electrode methods. Tensile strength of welds exceeds the 42,000 psi minimum tensile strength guaranteed for alloy 5456 in the annealed temper. Ranging in thickness from .250 to 2.0 in., plate is produced in the 0 and H321 tempers. Typical mechanical properties of alloy 5456-H321 are 51,000 psi tensile strength, 37,000 psi yield strength, and 16 per cent elongation.

SANTOS DUMONT was NEWS

Santos Dumont was not a place, but a person — from Brazil. He gained a great deal of attention in 1907, when he flew an aeroplane a distance of 235 yards in 21 seconds — carrying a passenger! This historic flight took place in Paris, and was "news" all over the world. Curiously enough, few people at that time were aware of the Wright brothers' history-making flight at Kitty Hawk in 1903; most people then thought of "aviation" as floating about in balloons or dirigibles. It was something you watched at the County Fair — or perhaps at the International Bennett Cup Race.

In this era of scientific and industrial pioneering, our founders Soren Sorensen and John Christensen came west to Cincinnati and started making gears. Cincinnati Gear's beginning was as modest as the aviation industry's; and like the aviation industry, we have grown and progressed significantly in the past fifty years. But one thing has not changed — our old fashioned attention to detail, that insures our gears being 100% *right* every time. It results in a reliability and dependability that our customers like — that *you'll* like too. Why not try us for your next custom gear order?

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CINCINNATI 27, OHIO
Fifty Years of "Gears—Good Gears Only"

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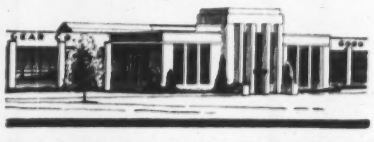


KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Transfer Forming Machine

A new 3-station in-line transfer forming machine that produces four bends and contours in hot rectangular steel bars during one station operation is available from Expert Automation Machine Co., 17144 Mt. Elliott Ave., Detroit 12, Mich.

All bending and contour forming operations are performed in one working station to allow complete forming of the part while it is still at the required temperature for bending. This design also reduces overall machine size, the firm reports.

In the working station, an overhead hydraulically operated ram performs one bending operation while a hydraulically operated die set performs the three remaining bending operations. The company says that with this type of design, the machine can be adapted to a variety of parts requiring various bends and contours by changing the die set.

The forming machine which produces 500 formed automotive bumper support arms per hour, is an in-line transfer type machine in which the parts are automatically transferred from station-to-station by means of a hydraulically operated walking beam transfer mechanism.

Parts to be formed are automatically fed from a furnace, which preheats the bar, to the transfer mechanism of the machine. The transfer mechanism is operated by two hydraulic cylinders which lift the mechanism vertically by means of a bell crank type linkage and move it into the machine in a horizontal plane. The transfer mechanism then moves vertically downward and places the hot bar in the station two fixture. The transfer mechanism then moves outward from the machine to starting transfer position.

In station two, four bends and contours are made on the hot bar by means of an overhead ram and an underslung die set. To begin forming operations, the ram moves downward and forms a concave contour in the bar. With the ram still in the down position, an hydraulically operated center die then moves up and produces a curve in the center section of the bar. Two hydraulically operated cone benders then form a 90-deg offset angle on the bar ends. Two hydraulically operated edge benders then further displace the bend to required dimensions in the tangent plane of the cone.

After forming operations are completed, the ram and die set retract and the finish formed bumper support is transferred to station three where it is placed on a chain conveyor which rapidly carries the part to a salt quenching tank.

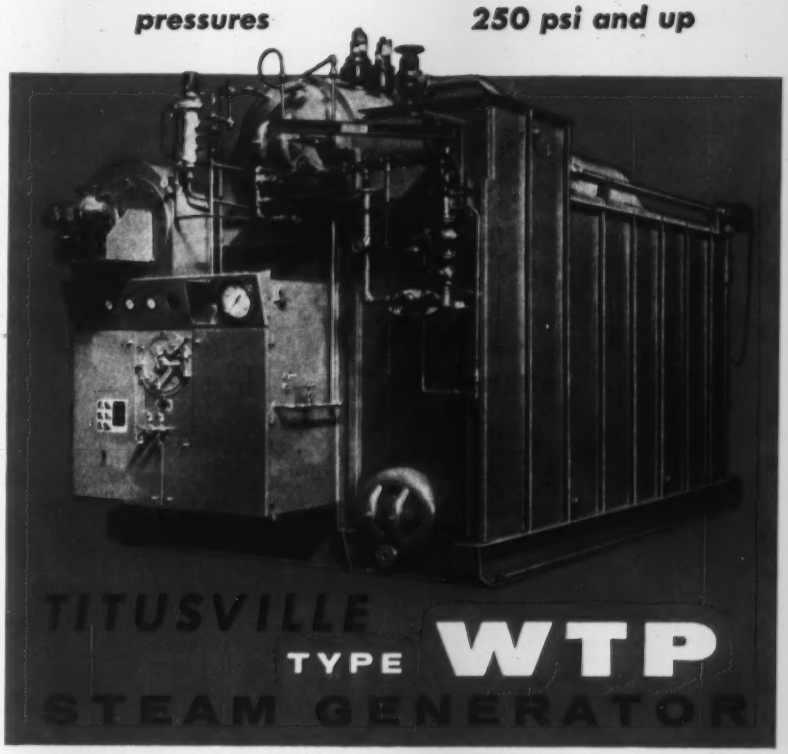
The three-station machine occupies a floor space of about 5 × 10-ft and is 11-ft high. Two 15-hp hydraulic power units operate all movements of the machine. The machine weighs approximately 10 tons.

For Consulting Engineers Turn to Page 162

PERFORMANCE

Meeting Your Most Rigid Requirements—in Capacities to 60,000 lbs.

pressures 250 psi and up



Tops in steam generating performance is matched by outstanding dependability in Titusville's Type WTP Water Tube Steam Generators. Completely factory-assembled, ready to ship by flatcar or truck trailer, Type WTP is easy to install in your boiler-room. • Let us show you why and where Type WTP is serving many of the toughest boiler assignments in the country. When writing, ask for Bulletin 5511.

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BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units
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Manufacturers of A Complete Line of Boilers for Every Heating and Power Requirement
Plants at Titusville, Pa. and Warren, Pa.
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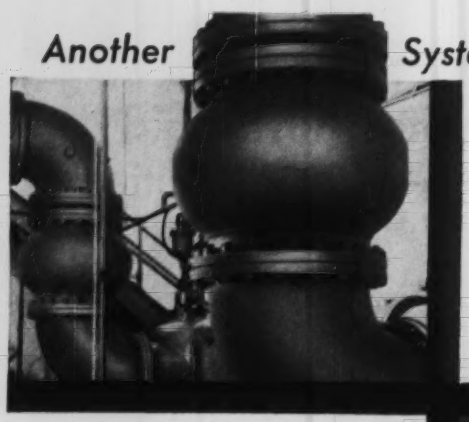
Another System Made



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Here is protection against damage from surge pressures . . . the means to eliminate resulting water hammer. They operate instantly when flow reversal starts or when flow is zero. Write for descriptive Bulletins.

WILLIAMS-HAGER Silent CHECK VALVES

Write for Bulletins No. 654 on the Valves; No. 851 on Cause, Effect and Control of Water Hammer

THE WILLIAMS GAUGE CO., INC.
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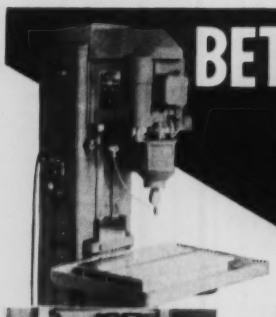
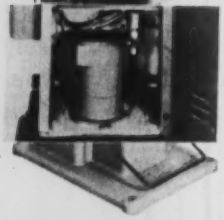
RUTHMAN
GUSHER
Coolant Pumps





Simple in design with fewer moving parts to wear, Gusher Coolant Pumps will give you year after year of very efficient service at very low maintenance cost. The pre-lubricated heavy-duty ball bearings require minimum attention. The electronically balanced rotating assembly eliminates vibration. Always specify Gusher Coolant Pumps for a trouble-free coolant system.

Type 1 P-3 Short

Illustrated is a Snow Manufacturing Co. Single Spindle Vertical Full Universal Tapping Machine equipped with a Gusher Pump.

THERE'S A GUSHER FOR EVERY REQUIREMENT

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Ruthman MACHINERY CO.

• COOLANT PUMPS
• CIRCULATORS • AGITATORS
• MOLTEN METAL PUMPS

1823 Reading Rd. Cincinnati, Ohio

KEEP INFORMED — NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Impedance Bridge

A universal impedance bridge assembly, Model 291, with a-c and d-c generator and detector units, is announced by Electro-Measurements, Inc., 7524 S. W. Macadam, Portland, Ore.

The instrument is contained in a portable carrying unit. The firm says that when closed, the instrument, including all panel controls, test leads and accessories, is completely protected. The bridge may also be mounted in a standard 19 in. relay rack.

For d-c measurements of resistance and conductance, the built-in generator, operated from a 115 v, 50-60 cycle a-c power line, can provide either 10 v or 300 v to the bridge. During the balancing operation, bridge nulls are detected on a light beam type galvanometer having a deflection sensitivity of 30 mm per μa.

An adjustable 0 to 15 v power supply, operable from 100 cycles through 10 kilocycles, is available for a-c impedance measurements. Frequency selections are made by means of plug-in networks. Visual detection of bridge balance is provided for by use of a dual electronic ray indicator having instantaneous response to a wide range of signal changes. Terminals are provided for accommodating other types of detectors when desired. Ample gain allows null indicator sensitivity to 20 μv or less.

Corrugated Expansion Joints

A line of improved corrugated expansion joints in which movement of power and process piping systems is shared equally by all corrugations is available from Zallea Bros., Wilmington, Del.

Called Duo Equalizing expansion joints, the units are used in all-weather outdoor piping systems and for indoor systems operating on frequent on and off cycles to protect piping and related equipment against damage due to temperature change.

Equal distribution of pipe expansion and contraction to all of the corrugations is accomplished by pantographs, the firm explains. The pantograph neutrals are anchored to the unit's end fittings and intermediate equalizing rings. Any end fitting movement is immediately transferred by the pantograph to all equalizing rings. This moves all rings the same distance at the same time to give uniform use of all corrugations and prevent undue stress to any one corrugation, it is reported.

The company says the new expansion joints feature four design improvements: 40 per cent longer life than self equalizing expansion joints at the same pressure and movement, 30 per cent less overall length, 30 per cent less weight, and greater stability at high pressures because of the reduced ratio of length to diameter.

The joints are made from stainless steel in sizes from 3-in. diam to 72-in. diam and for traverses up to 7½ in. in a single or 15 in. in a double unit. Standard units are designed for 150 and 300 psi working pressures, but can be made for higher pressures.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Tape Recording System

A portable 300 kc bandwidth system is now being manufactured by the Recordata Div., American Electronics, Inc., 655 W. Washington Blvd., Los Angeles 15, Calif.

The company says an exclusive feature of this multi-channel magnetic tape recording system is the selection, either remotely or from the front panel, of six speeds with appropriate equalization built-in to automatically compensate for each speed.

Proper speed and equalization from $1^7/_8$ to 60 ips are obtained by turning the speed selector. The portable Series 3000 300-kc system accommodates reel sizes up to 14 in. as standard equipment and may be ordered to utilize 19 in. reels. Continuous loop versions are also available. Tape tension is held constant within plus or minus $^1/_4$ ounce from beginning to end of reel by a servo-system.

Packaged in four units, this system can be transported for field use. It is compatible with existing systems, the company states.

Magnetic Motor Starter

A new NEMA Size 0 and 1 magnetic motor starter that is 42 per cent smaller than previous open forms, has been developed by the General Electric Co.'s General Purpose Control Dept., Schenectady 5, N. Y., for such applications as machine tools, pumps, hoists, blowers, saws, compressors, mixers, and packaging machinery.

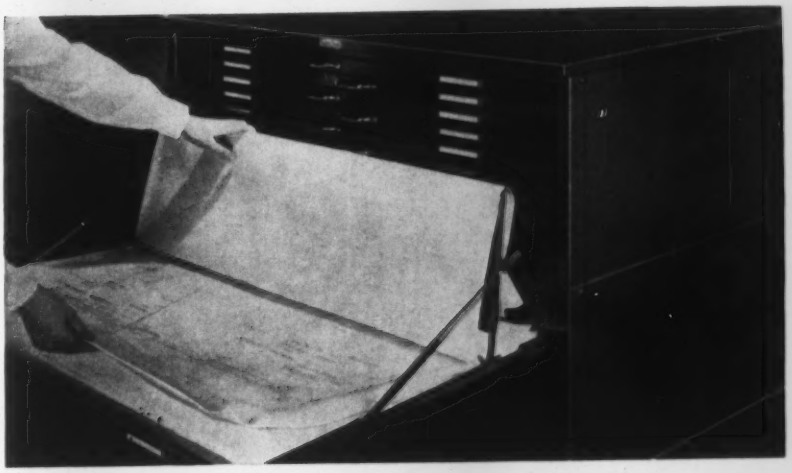
The new starter is of snap-slide construction. Principal components snap or slide together for quick inspection and maintenance. Contacts can be inspected in seconds, without using tools, the company claims.

By turning a knob on each of the two overload relays, the overload trip setting can be adjusted up to ±15 per cent of nominal heater rating. A new strongbox coil said to require a lower inrush current, permits a reduction in cost and mounting space requirements for a control transformer. The improved coil makes possible the use of a 47 per cent lower rated transformer than with previous starters.

The new starter can be mounted in any position. The unit's baseplate has three keyhole slots for mounting in the enclosure. The starter slides into place on mounting screws which support the starter while the screws are being tightened. Since the coil is removed from the front, new starters can be mounted closer together on a panel.

All wiring on the magnetic starter, including work on interlocks and overload relays, can be done from in front of the unit, the company reports. Even though the starter is smaller than previous units, the new enclosure has 32 per cent more wiring space. The enclosure has a total of ten combination knockouts for wiring convenience.

Leads go directly to all line terminals at the top and from all load terminals at the bottom. Wiring is done with new pressure-type terminals which can take stranded or solid wire up through size eight.

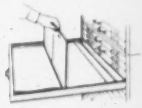


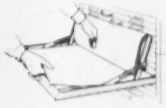
every tracing's a top tracing in a . . .

Hamilton

Shallow Drawer Unit

This remarkable, ten drawer file safely stores 1000 tracings, yet any one of them is instantly available.

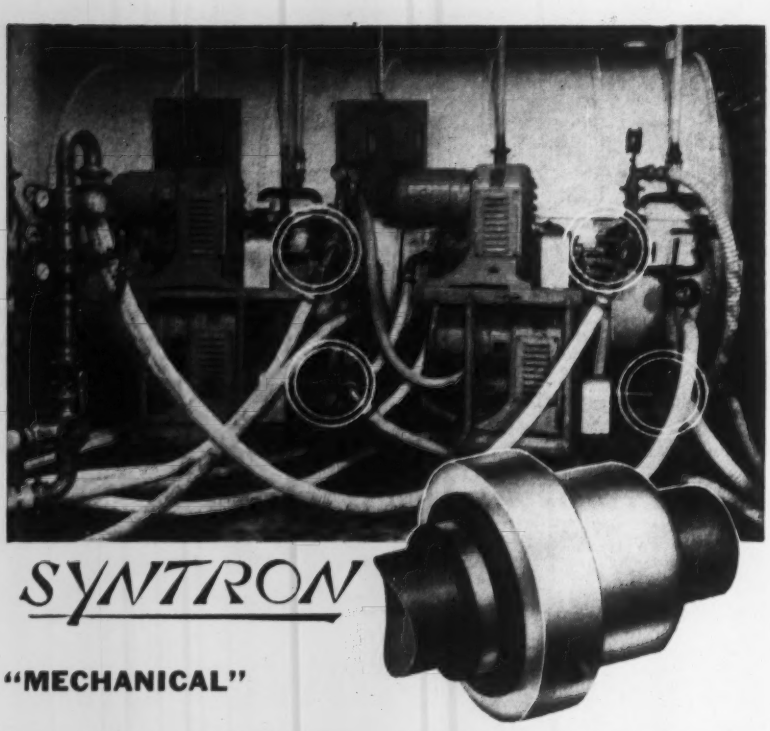
There's a patented *tracing lifter* in each file drawer. Just raise the lifter,  locate the desired drawing, and fold back all the sheets above it.

The tracing you want is now on top—easy to slip out  and replace with no danger of wrinkling or tearing.

Here's a fast and safe way to handle your valuable active tracings—and only Hamilton Shallow Drawer Units have it!

Hamilton

DRAFTING EQUIPMENT



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SHAFT SEALS

Provide a positive trouble-free seal around rotating shafts

Syntron Shaft Seals are successfully handling difficult liquids and gases. Provide a positive-leak proof seal around rotating shafts for long periods without maintenance or adjustment.

Syntron Shaft Seals are built as a single, easy to install unit. Seal faces are lapped to precision flatness. Inner sealing parts rotate with shaft—will not score, or damage shaft. Self-lubricating, automatic pressure balance eliminates periodic adjustment and maintenance.

Stop leak waste, lower maintenance costs. Meet your sealing problems with Syntron Mechanical Shaft Seals . . seals of proven dependability.

Write to our application engineers for recommendations.

Builders of Quality Equipment for more than a Quarter-Century.

Other SYNTRON Equipment of proven Dependable Quality

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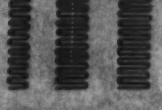
SINUATED WIRE



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498 Lexington Avenue Homer City, Penna.

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

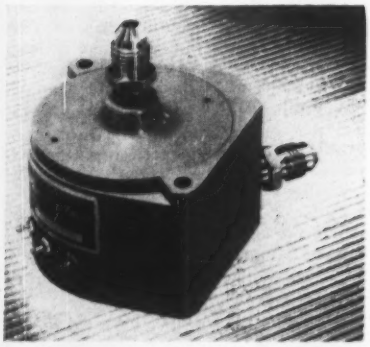
Adjustable Cam

Atlas Valve Co., 280 South St., Newark 4, N. J., announces the availability of a redesigned adjustable cam, lever-operated valve for accurate metering control of fuel oil in industrial oil burner installations.

The valve, Type 235, is designed to control and maintain a certain flow ratio between two variables such as air and fuel oil into an oil-fired steam boiler. According to the company, it may be used in applications where the flow of two fluids must be kept within specified ratios such as the control of steam for atomizing fuel oil, the control of steam-driven blowers or stokers, or the control of gas-air ratios to burners.

The valve has a flexible sheet metal cam, the contour of which is adjusted by a series of 24 screws. Cam is attached to a lever which moves it in accordance with a demand motion from the other variable. A roller on the stem presses against the cam and in following the pattern of the cam adjusts flow through the valve.

Features include seats furnished with $^{3}/_{8}$ in. diam. bore in single seated valves and as required in double seated valves; disks furnished with restriction plugs having the correct V-port for the maximum flow required; interchangeable parts; operating lever which can be set in any position to accommodate the linkage.



Pressure Transducer

A pressure transducer that operates continuously in temperature from −65 to +300 F with less than 1.0 per cent deviation is now in production at Edcliff Instruments, Box 307, Monrovia, Calif. The company says the transducer also can be ordered for operation up to +400 F. Model 2-8-2 withstands vibrations of +25g on all axes, and overpressure of up to 50 per cent causes no shift in calibration, it is reported. It is available in pressures ranging up to 10,000 psi absolute, gage, or differential, with an overall error of less than +1.0 per cent.

Gage and absolute units of this potentiometer-type instrument can be used in systems involving corrosive fluids or gases, the firm states.

Ticket - to your future

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Decatur, Alabama

1957

C 57

GROUND FLOOR ADVANTAGES

CHEMSTRAND

TECHNICAL PERSONNEL MANAGER,
Dept. ME 8-57
The Chemstrand Corporation,
Decatur, Alabama

Gentlemen:

It is my understanding that you need for immediate employment graduate engineers in various fields, particularly chemical, mechanical, industrial, textile and instrument engineering.

I am a graduate _____ engineer. Please send me information concerning the ground floor opportunities at Chemstrand.

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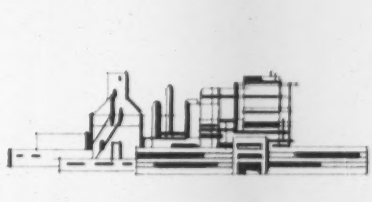
STREET _____

CITY _____ ZONE ___ STATE _____

Mr. Engineer! Looking for a free ride? Then this is not for you.

Mr. Engineer! Looking for a future filled with opportunity for accomplishment and recognition? Then this may well be the ticket to your future.

Let's exchange facts. Fill in and mail your ticket today!



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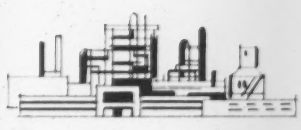
- ★ Chemstrand, already a leader in a dynamic, growing industry, is in its sixth expansion in five years.
- ★ The greatest future for the chemical-textile fiber industry still lies ahead. There is still time to get in on the ground floor... with The Chemstrand Corporation.



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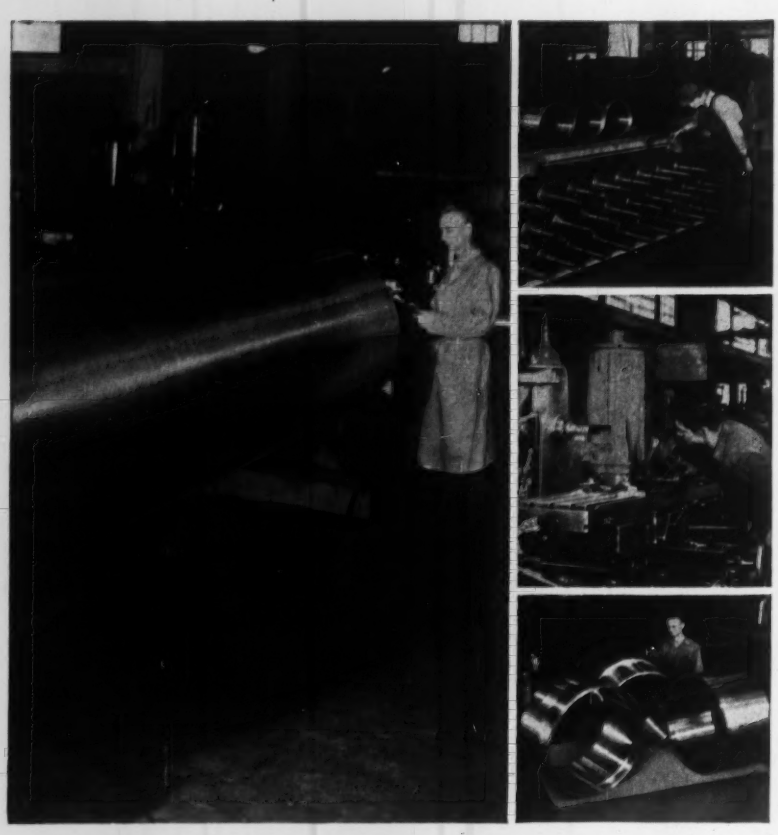
*® Acrylic Fiber by Chemstrand Corporation

ENGINEERS

Chemical, Mechanical, Industrial, Instrument and Textile

Immediate openings available at Chemstrand's Nylon Plant at Pensacola, Florida, and Chemstrand's Acrilan* Plant, General Engineering Department, and Research & Development Center at Decatur, Alabama.

TOMORROW'S BIG DECISIONS WILL BE MADE **by the men who act today...**



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SHENANGO CENTRIFUGAL CASTINGS

WHATEVER the inside or outside pressures, Shenango centrifugal castings are better able to withstand them without failure.

Parts cast by the Shenango centrifugal process are much tougher because their finer, *pressure-dense* grain avoids stress concentrations while providing greater strength, better elongation and freedom from such costly defects as sand inclusions, blowholes and such.

Whether you need rings, rolls, sleeves, liners, bushings, bearings, mandrels or *any* annular or symmetrical part . . . ferrous or non-ferrous . . . in whatever shape, size or dimension to meet your requirements . . . Shenango can do the job. And do the job *better!*

For informative bulletins on the answers to your tough problems, it will pay you to write now to: *Centrifugally Cast Products Division,* The Shenango Furnace Company, Dover, O.

SHENANGO CENTRIFUGAL CASTINGS

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MONEL METAL · NI-RESIST · MEEHANITE METAL · ALLOY IRONS

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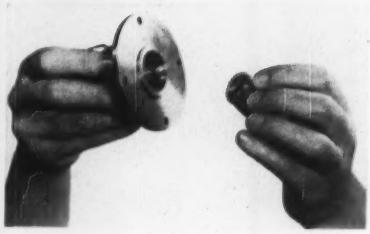

Magnetic Brake

A new magnetically released, spring set miniature brake is announced by Stearns Electric Corp.

It is designed for application on computers, antenna control for radar, and valves on atomic reactors.

Torque rating brake is 25 oz-in., and it consumes 4.9 w. Approximate physical dimensions are $1^3/_8$ in. in diam by 2 in. long, and it weighs slightly more than $8^1/_2$ oz.

The miniature brakes have been designed for direct current application and are wound for 28 v. The company says a special metallic bonded friction lining is used to give long wear, high torque, high thermal capacity, and additional strength.

Elapsed Time Indicator

A new elapsed time counter indicator distinguished by its miniature size and light weight is now in production at Magnetic Instrument Mfg. Corp., Thornwood, N.Y.

The new unit is designed for use in airborne or ground equipment where it is necessary to keep an accurate record of actual "on" time. Typical applications include radar sets, computers, navigation systems, the firm says.

Principal design features include a new type of low speed synchronous motor and a gear train arrangement which provides a 14,400:1 ratio while utilizing only four gears.

The indicator measures $1^1/_4 \times 1^1/_4 \times 2^1/_4$ in. and weighs 4 oz. Time range is 9999.9 hr indicated on five counter wheels. Entire unit is hermetically sealed and includes two No. 6-32 tapped holes on the face for front mounting in a single rectangular panel cutout.

Driven by a precision synchronous motor, the accuracy of the indicator is a direct function of the input line frequency. Power consumption is 3.5 w at 26 or 115 v a-c, 400 cps. The unit is designed to meet the environmental conditions of MIL-E-5272A.

Back-Up Rings

Back-up rings of Teflon used in conjunction with O-ring seals in hydraulic and similar pressure systems are announced by Sparta Mfg. Co. Dept. Me., Dover, Ohio.

The use of Teflon back-up rings with rubber O-rings gives a better seal, less wear on the O-ring, and eliminates deforming of the O-ring by extrusion under pressure, the company claims.

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29 West 39th Street
New York 18, N.Y.

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MECHANICAL ENGINEERING—SEPTEMBER 1957 Issue

IFC	17	31	47	62	76	89	102	111L	124	137	150	179
1	18	32–33	48–49	63	77	90L	103	111R	125	138	151	IBC
2	19	34	50	64	78	90R	104	112	127	139	153	OBC
3	20–21	35	51–52	65	79	91	105	113	128	140	156L	
4–5	22–23	36	53	66	80	92T	106L	114L	129	141	156TR	
6–7	24	37	55	67	81–83	92B	106T	114R	131	143	157	
8–9	25	38–39	56–57	68	85	93	108B	115–116	132	144	158T	
10–11	26	40–41	58	69	86	94	109T	117	133	145	158BL	
12–13	27	42–43	59	71	87	96	109B	119	134	147	160TR	
14–15	28–29	44–45	60	73	88L	99	110L	121	135	148	161	
16	30	46	61	74	88TR	101	110R	123	136	149	177	

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2	19	34	50	64	78	90R	104	112	127	139	153	OBC
3	20-21	35	51-52	65	79	91	105	113	128	140	156L	
4-5	22-23	36	53	66	80	92T	106L	114L	129	141	156TR	
6-7	24	37	55	67	81-83	92B	106T	114R	131	143	157	
8-9	25	38-39	56-57	68	85	93	106B	115-116	132	144	158T	
10-11	26	40-41	58	69	86	94	109T	117	133	145	158BL	
12-13	27	42-43	59	71	87	96	109B	119	134	147	160TR	
14-15	28-29	44-45	60	73	88L	99	110L	121	135	148	161	
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KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Rubber-Metal Adhesive

A new adhesive for bonding cured natural or synthetic rubber to metal, said to provide a bond so strong that the rubber will tear before it can be peeled from the metal, has been announced by Adhesives Dept., Raybestos-Manhattan, Inc., Bridgeport 2, Conn. The new adhesive is designated as Ray-Bond R-86001.

Cured in 24 hr at room temperature (77 F) the adhesive reaches maximum strength after seven days. To reach maximum strength immediately, it may be cured in 4 hr at 120–140 F.

Seven-day immersion tests in 10 per cent hydrochloric acid, 3 per cent sulphuric acid, 10 per cent ammonium hydroxide or 10 per cent sodium hydroxide have shown no visible effect on the bond, the company reports. Rubber linings under peel or shear stress can be bonded for use in temperatures up to 100 F. Dielectric strength is 400 to 450 v per mm.

The adhesive is a two-component adhesive consisting of a synthetic resin base and an activator. The two components are mixed before application. The resulting paste can be used for as long as 4 hr after mixing. If the activator is preheated the components may be mixed in continuously for continuous application, using conventional metering and mixing machines.

Air, Hydraulic Cylinder

An air and hydraulic cylinder, designed for extra strength and resistance to outside damage, is being produced by Remco Mfg. Co., Petaluma, Calif. They are available as standard items or custom made.

According to the company, external threads on the cylinder barrel, with internal threads on the heads, prevent cylinder "breathing" under high pressures. This is designed to end problems of bending tie-rods and of snap-ring failures. With outside threads on the cylinder, full use is made of internal honed tubing surface, providing a longer than ordinary stroke or a shorter over-all length of cylinder, the firm states.

Cylinder heads are made of cast steel and are O-ring sealed. Cylinder barrels are made of extra heavy wall, precision honed, seamless steel tubing.

Properties of Steam at High Pressures

This is an interim steam table covering a range from 5500 to 10,000 psi and 32 to 1600 degrees F. It is published to provide a reasonable extrapolation of the current tables that will be useful in power systems calculations until an authoritative steam table has been published—five years hence.

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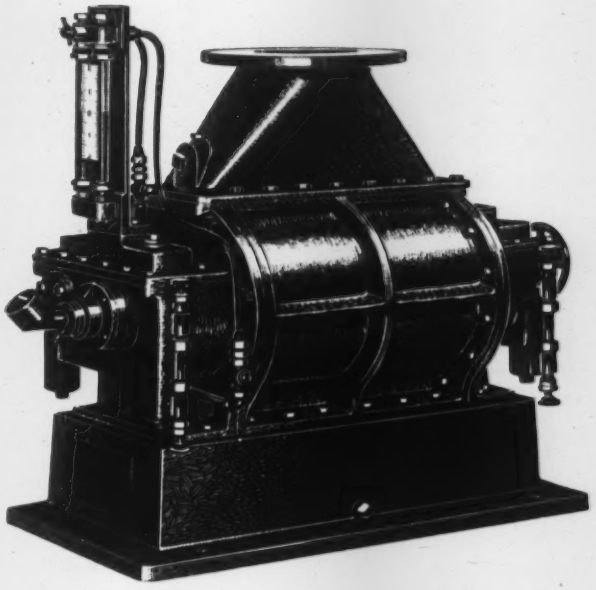

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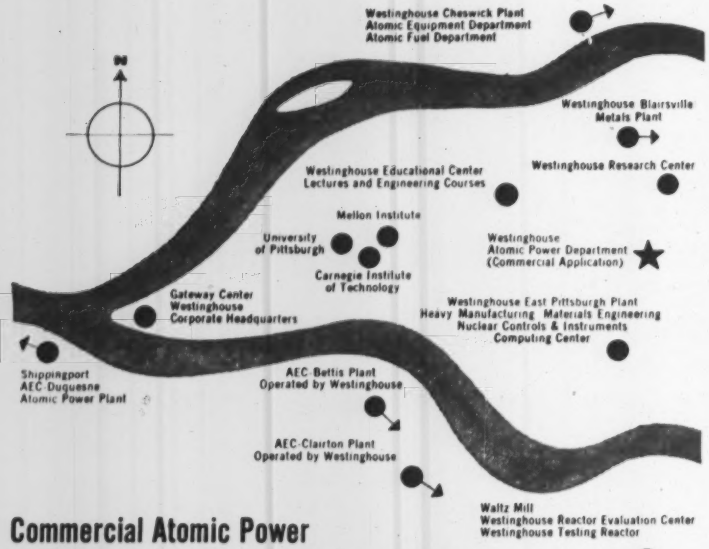
Hydraulic System

A new hydraulic system said to eliminate hydraulic heat at its source is announced by Thompson Grinder Co., Springfield, Ohio.

According to the company, the system during extensive tests has shown only a 3 deg temperature rise over ambient room temperature during continuous 24-hr production runs. This rise is compared to temperature increases ranging from 50 to 70 deg which now prevail in other types of surface grinder hydraulic systems, the firm states.

The unit, called Hydra-Cool, is a pressure-compensating, variable delivery system in which the delivery of oil is automatically compensated both as to volume and pressure requirements.



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6 Commercial Atomic Power Programs Now Under Way

1. A 150-megawatt homogeneous reactor for the Pennsylvania Power & Light Co.
2. The first industry-owned testing reactor for nuclear-materials study. (Owned by Westinghouse.)
3. A 134-megawatt reactor for Yankee Atomic Electric Co.
4. A 134-megawatt atomic plant for Edison-Volta, Italian power company.
5. An 11.5-megawatt pressurized water reactor for Belgium.
6. An atomic power plant study for the Carolinas-Virginia Nuclear Power Associates.

. . . and more programs, national and international, are coming in.

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Send résumé to: C. S. Southard, Westinghouse Atomic Power Department, Box 355, Dept. 121, Pittsburgh 30, Pa.

Westinghouse

FIRST IN ATOMIC POWER

Stepping Motor

Development of a precision bi-directional stepping motor, named Syncramental motor, has been announced by G. H. Leland, Inc., 123 Webster St., Dayton, Ohio.

The motor translates pulses to incremental shaft positions. Uses include rotation of potentiometers, counters, rotary switches and control mechanisms.

The new motor features a special magnetic clutch, rather than ratchets, to index the shaft. The clutch and detent mechanism are mounted between two Ledex rotary solenoids whose armature plates face each other. The clutch rotates with one or the other of the energized armatures to which it has been magnetically attracted, causing shaft rotation. Solenoid de-energizing returns the armature to its original position, while the clutch and shaft are held in displaced position by the detent. According to the company, an advantage of this drive is a reduction in shaft overcoast. The clutch surfaces provide a braking action at the end of each step for higher inertia loads.

Angular increment per pulse is 36 deg in either direction at a maximum stepping rate of 15 per sec. A load capacity up to 2 lb-in. starting torque at 20 C is provided. Life expectancy is 2 million steps in either direction. Temperature range is −55 C to 120 C at altitudes up to 90,000 ft. The motor is 1500 diam × 2525 in. long, weighing 13 oz. Mounting is standard Servo.

Control Valve

A fully automatic 4000 lb 3-way neutral 2-pressure control valve, designed for automated control of presses, plastic molding machines and similar equipment, is announced by Sinclair-Collins Valve Co., 454 Morgan Ave., Akron, Ohio.

Upon actuation, the company explains the new valve applies low pressure for fast controlled closing of the press or machine. Then, triggered by control timer interval or limit switch, the high pressure is applied. When processing is completed, high pressure cuts off, the drain valve opens and the press or machine opens. The valve can be adjusted to provide any throttling speed in any position of the closing and/or opening strokes. A manually operated safety control permits instant reversal at any point in the closing phase of the cycle.

Designed for use with raw water as well as other fluids, the valves handle high velocity fluids without erosion, the manufacturer states. Resistance to corrosion and to the cutting action of high velocity fluids is afforded by cast bronze valve bodies, Monel metal stems with Stellite-faced seats and replaceable hardened stainless steel seat sleeves. Valves are reputed to provide smooth, shock-free operation since the stem is in hydraulic balance and pressures increase gradually as the stem uncovers the port holes in the seat sleeve.

KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Vibration Equipment

A new line of high-powered amplifiers and shakers designed for vibration and fatigue testing is now available through Genisco, Inc., 2233 Federal Ave., Los Angeles 64.

They recently concluded a reciprocal sales agreement with W. Bryan Savage, Ltd., London, England, manufacturers of the equipment. The new products will be marketed in the United States under the trade name Genisco-Savage.

Initially, two amplifiers and a shaker will be available: Models KCD and KLF power amplifiers and the Model 600 shaker.

The Model KCD Power Amplifier is said to be capable of continuous duty operation at full 1000-w power output. Originally designed for radio-relay installations, the amplifier is claimed to have exceptionally good output regulation and a low noise level. A special Model 10K amplifier has a continuous rating of 10,000 w at frequencies from 40 to 10,000 cps.

The low-frequency power amplifier incorporates high power output, negligible distortion, exceptionally high reliability and stability, excellent output voltage regulation, and a multi-ratio output transformer to facilitate correct matching to the load, the company states.

The shaker incorporates such features as a very light moving coil assembly, a high thrust-to-weight ratio, automatic impedance matching and an excellent output waveform. The new shaker has been stress-tested to withstand continuous operation at accelerations of 100 G's.

Ionization Gage

A new ionization vacuum gage which gives continuous pressure readings on eight linear ranges from 1×10^{-3} to 2×10^{-12} mm Hg is available from the Rochester Div., Consolidated Electrodynamics Corp., 1775 Mt. Read Blvd., Rochester 3, N. Y.

Called the GIC-100, the instrument has been designed to control, read, and degas any type of commercially available ionization tube.

The emission control is variable over a continuous linear range from 25 ma to 20 ma, and is regulated throughout the range to ±2 per cent. This, along with the greatly increased aimplifier gain, enables the operator to control the sensing tube at a greatly reduced emission current, the firm states. The result is reduced ion pumping and x-ray effects.

Tube degassing by both resistance and electron bombardment is provided. The degassing current is variable, and pressures can be read continuously while the tube is degassing.

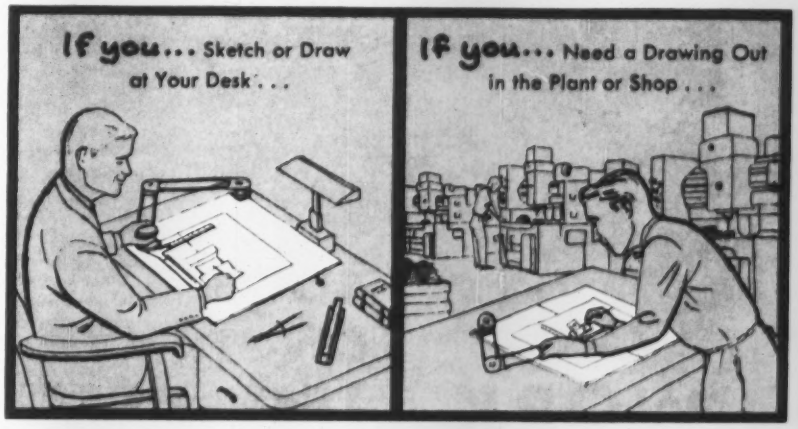
An accessory two-station thermocouple circuit is available with a range from 1 to 1000 micron Hg. Pressure for either of the two stations can be read directly in microns Hg on a special scale of the same meter used for the ionization gage reading.

Alloy Steel Studs

New alloy steel studs which are double drawn and heat-treated to prevent thread distortion and stud failure are announced by Jergens Tool Specialty Co., 712 East 163 St., Cleveland 10, Ohio.

The studs, used principally in tool and die work for machine and fixture set-up, are reported to last up to five times longer than ordinary studs resulting in substantia savings in materials, man-time, and machine shut-down time.

According to the manufacturer, these heat-treated alloy steel studs have tensile strengths of over 125,000 psi. They are now available in quarter-inch multiple lengths up to 12 in. long in diameters of $^1/_4$, $^5/_{16}$, $^3/_8$, $^1/_2$, $^5/_8$, $^3/_4$, $^4/_8$, and 1 in.



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ROCKFORD

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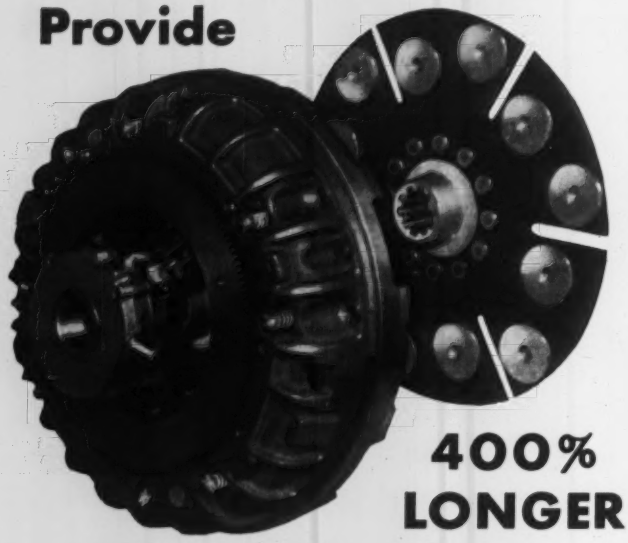

400% LONGER WORK LIFE

Reports from a wide range of users state that MORLIFE clutches serve from four to ten times longer than previous types of friction clutches using organic facing materials. Adjustments and plate replacements have been reduced to one-tenth those required by previous clutches. The longer on-the-job hours and increased pay loads which MORLIFE clutches make possible furnish a competitive advantage for machines in which these NEW clutches are used. Increased clutch life results in decreased operation cost of vehicles or equipment. Let our engineers show you how *your* product will benefit through using MORLIFE clutches.

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Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

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CLUTCHES

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Liquid Level Sensor

A new light weight, highly accurate liquid level point sensor for aircraft, missile fuel and oxidizer systems, and propellant control and commercial process control, has been announced by Acoustica Associates, Glenwood Landing, N. Y.

Designated Model RC-1A, the sensor operates on ultrasonic principles to detect the presence or absence of liquid at a predetermined level.

According to the company, the sensor features no moving parts, high sensitivity, virtually instantaneous response, no spark or radiation hazard, infinitesimal power drain. It operates over a range of ambient temperatures from −200 to +125 C.

The basic sensor consists of a miniaturized hermetically sealed ultrasonic probe, measuring approximately 2 in. in length and $^{11}/_{16}$ in. OD. The probe is mounted vertically in a tank and an associated plug-in type, hermetically sealed electronic control unit is placed at any convenient location external to the tank. The probe, which weighs 1 oz, is always at the ambient temperature of the liquid being gaged, the firm states. Weight of the control unit is 6 oz.

The sensor has a response time of less than 10 milliseconds, a total power drain from a 24-29 v d-c source of 15 milliwatts with the control relay de-energized and 130 milliwatts with the integral signalling relay energized. According to the firm, the unit has the ability to sense level repeatedly to an accuracy of better than $^{1}/_{64}$ in. The probe will ignore foam or clinging droplets when used to gage all common aircraft fuels. Various modifications to the probe are available to meet particular mounting and connecting problems and to average out sloshing waves in moving tanks, the company reports. The sensor can also be used to detect presence or absence of fuel flow in pipes down to 1 in. diam.

The electronic control unit makes use of a single silicon transistor arranged so that absolutely no power is applied to the probe when it is immersed in fuel. When the probe is out of the fuel, there is insufficient power at the probe or in the connecting cable to ignite gasolene fumes under any possible set of circumstances. The RC-1A operates over an ambient temperature range from −55 C to 85 C and conforms to requirements of MIL-E-5400 and MIL-F-8615.

Various types of transducer probes capable of sensing liquid oxygen and other cryogenic as well as highly corrosive and radioactive liquids ranging from −200 C to 125 C are available.

LISTEN TO YOUR HEART

AND GIVE A LITTLE MORE

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Pressure Pickup

Norwood Controls, Unit of Detroit Controls, Div., American-Standard, Norwood, Mass., announces a new high-temperature pressure transducer designed for use in rocket and jet engines, high temperature chemical reactions and other high pressure, high temperature applications.

The new transducer uses the same catenary diaphragm and tubular strain gage as the firm's air-cooled pressure pickups and an efficient water cooling system enables the diaphragm to withstand gas temperatures above 5000 F. Frequency response is extremely high and is flat to 10,000 cps, the firm states.

All exposed parts are of stainless steel and will resist oxidation under very severe conditions, the company says. The transducer is said to be immune to external vibration and mounts flush so that the change of volume it causes in the pressure chamber is negligible. Models are immediately available for 0–1000 and 0–2000 psi ranges with 1 per cent of full scale accuracy and excellent temperature compensation.

Steel Wedge Gate Valve

For water, steam, gas or air service at temperatures up to 850 F and for oil or oil vapor up to 1000 F, a new line of 600-lb steel wedge gate valves has been designed by Walworth Co., 60 E. 42nd St., New York.

Valve body is of forged carbon steel. This valve has a nonshock pressure-temperature rating of 420 psi at 1000 F and a rating of 2000 psi at 100 F. Stem, wedge and seat rings are made of 13 per cent chromium stainless steel for longer service life. The wedge has a hardness of 500 Brinell and is accurately guided by ribs in the body, the firm reports.

All valves in the new line are of the outside screw and yoke design. These valves are designed to permit repacking under pressure when fully opened. Curved yoke arms and swing type eyebolts are said to provide free access to the stuffing box.

The valves are available with screwed or socket welding ends. Those with a union bonnet are available in eight sizes from $^1/_4$ to 2 in.; those with bolted bonnets, in six sizes from $^1/_2$ to 2 in.

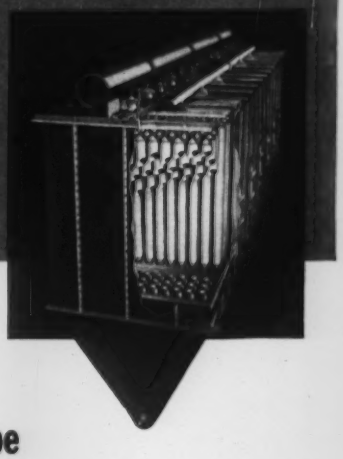
Nylon Filters

Complete all-nylon filters designed to withstand rust and corrosion in a wide range of applications have been announced by Danielson Mfg. Co., Danielson, Conn.

The filters are custom-molded in types, sizes and shapes to meet specific filtering requirements. One-piece nylon molding with nylon mesh and supporting structural frame injection-welded together in a permanent bond offer greater savings in original cost as well as in production assembly, according to the manufacturer.

Dust and Fume Collection by Norblo

helps you achieve efficiency and cleanliness in your plant



Norblo has developed bag type dust collection systems to a high degree of efficiency.

Norblo Automatic Bag Type

For continuous and heavy duty service at constant capacity and efficiency, Norblo Automatic Bag Type collection pays its own way — in recovery of valuable materials or removal of injurious or "nuisance" industrial air contaminants. Norblo builds the entire installation, from blowers to bag-cleaning mechanisms. Complete systems are engineered to meet specific situations. Norblo engineering insures low maintenance and no shut-downs — guarantees performance of every installation.

Norblo Standard Bag Type Collectors

Based on the same construction principles, the standard bag type collectors provide at low cost the high efficiency service that is obtainable only from bag-type cloth filtering, with either compressed air or electrically driven periodical bag shaking and cleaning. Units must be shut down for cleaning — at such times as the noon hour and end of working day.

Norblo Portable Type

For excellent results in localized dust control, Norblo Portables protect equipment and reduce maintenance in grinding, polishing and cutting departments. Six models cover capacities from 300 to 1350 cfm., at 8″ static pressure at the fan. Occupy small space. Are unusually quiet.

Write for bulletins describing Norblo bag type dust collectors.

The Northern Blower Company

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Norblo ENGINEERED DUST COLLECTION SYSTEMS FOR ALL INDUSTRIES

Using stop motion, photographer Bernard Hoffman 'freezes' a tiny jet of water. Discharged at high pressure, the stream is a solid, unwavering mass.

Controlling Pressure in Fluid Engineering

Pressure is always a problem . . . either how much you need, or what you can do in spite of it. Accurate control requires the relation of other factors, like volume, time, and resistance. To get these answers, you can depend on the engineering leadership of S. Morgan Smith.

Take butterfly valves. Parts for a wide range of standard R-S Butterfly Valves, capable of satisfying most processing requirements, are carried in stock for fast assembly and shipment. These R-S Valves, with their streamlined vanes, give you minimum pressure drop, save pumping power. Regulation and closure are quick, and you get uniform flow control through all positions in the normal regulating range.

To obtain full information on the complete SMS line – R-S Butterfly Valves, Rotovalves or Ball Valves – call our nearest representative. Or, write S. Morgan Smith Co., York, Pa., for data on standard valves or special applications.

S. MORGAN SMITH HYDRODYNAMICS

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

Rotovalves • Ball Valves • R-S Butterfly Valves • Free-Discharge Valves • Liquid Heaters • Pumps • Hydraulic Turbines & Accessories

Vibratory Feeders

Eriez Mfg. Co., Erie 6, Pa., announces production of a new, improved line of Hi-Vi electro-permanent magnetic vibratory feeders.

The feeders are said to provide greater output than other units of comparable physical size and give high operating efficiency over a broad operating range.

The drive element in the new units is completely enclosed. Special disk-shaped springs of bonded glass fiber replace the metallic leaf springs used in old-style vibratory equipment. These glass fiber springs are not subject to corrosion or packing, the firm says.

The units have an electro-permanent magnetic drive system that requires no rectifier. The feeder operates at 3600 cpm directly off an a-c line. The rectifier is replaced by an Alnico V magnet.

Sparta Expands

Sparta Mfg. Co., Dover, Ohio is increasing its capacity for coating with Teflon metallic and nonmetallic parts. The new plant will have an additional 5000 sq ft of area.

Indiana Representative

Brosey Engineering Co., 648 E. 54th St., Indianapolis, has been appointed representative for Indiana for Ledeen Mfg. Co., E Monte, Calif. The company manufactures air and hydraulic valves and cylinders, valve actuators, boosters, air hydraulic pumps and hydraulic power units.

To Produce Silicon

W. R. Grace & Co. of New York and Pechiney, chemical and metallurgical concern of France, have announced the formation of a new company in the United States to produce high-purity elemental silicon and other semi-conductors.

South Eastern Distributor

Federal Machine & Welder Co., Warren, Ohio, manufacturers of welders and presses, has announced the appointment of a new Southeastern sales representative. The new sales associate is C. G. Notley & Co., Industrial Sales Engineers of Charlotte, N. C.

Plant Addition

Construction of a $300,000 addition to its plant at Keene, N. H., has been announced by Miniature Precision Bearings, Inc.

The new facilities will add more than 25,000 sq ft, to the present 50,000 sq ft quarters. It is scheduled for completion by January 1, 1958.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Moves to New Plant

A new $1.5-million plant for the production of industrial valves for automation and the nation's expanding missile program has been opened in Fort Washington, Pa., by Minneapolis-Honeywell Regulator Co.

The 120,000-sq ft plant, located on a 25-acre site in Fort Washington's Industrial Park, 12 miles north of downtown Philadelphia, provides manufacturing, research and development, sales and administrative facilities for Honeywell's Valve Div.

Buys West Coast Firms

Arwood Precision Casting Corp., 321 W. 44th St., New York, N. Y., has completed negotiations for the purchase of the Duncan-Rohne Co., and the Malco Metal Products Co., both of North Hollywood, Calif. Duncan-Rohne is the largest producer of nonferrous investment castings on the West Coast and Malco specializes in the machining of castings. Both companies will continue to operate at the North Hollywood location as subsidiaries of Arwood.

New Office, Warehouse

Occupancy of a new office and warehouse building by the American Chain & Cable Co., Inc., in the central manufacturing district of Los Angeles, has been announced. The new structure, occupancy of which has followed the outgrowing of the firm's previous building, is the second of a group of four being built. The construction program comprises several structures to house some 40 new industries and will represent a total investment of some $38 million when completed.

New Bellwood Office

Manning, Maxwell & Moore, Inc., manufacturer of industrial devices, cranes, hoists, and other types of industrial products has opened a new district office and factory warehouse in Bellwood, Ill. The company will maintain at the new warehouse, stocks of certain of its products to augment the inventory of its industrial distributors. In addition, safety valve setting equipment will permit quicker service in the delivery of valves in the greater Chicago area, the firm states.

New Virginia Dealer

Crunkleton Co., 920 Fourth St., S. E., Roanoke, Va., has been appointed to sell and service the fork-lift trucks, straddle carriers and powered hand trucks produced by the Industrial Truck Div., Clark Equipment Co. The dealer will handle sales in the Virginia counties of Rockingham, Augusta, Highland, Bath, Alleghany, Rockbridge, Amherst, Botetourt, Bedford, Campbell, Charlotte, Halifax, Pittsylvania, Henry, Patrick, Franklin, Roanoke, Craig, Giles, Montgomery, Floyd, Carroll, Pulaski, Bland, Wythe, Tazewell, Smyth and Grayson.

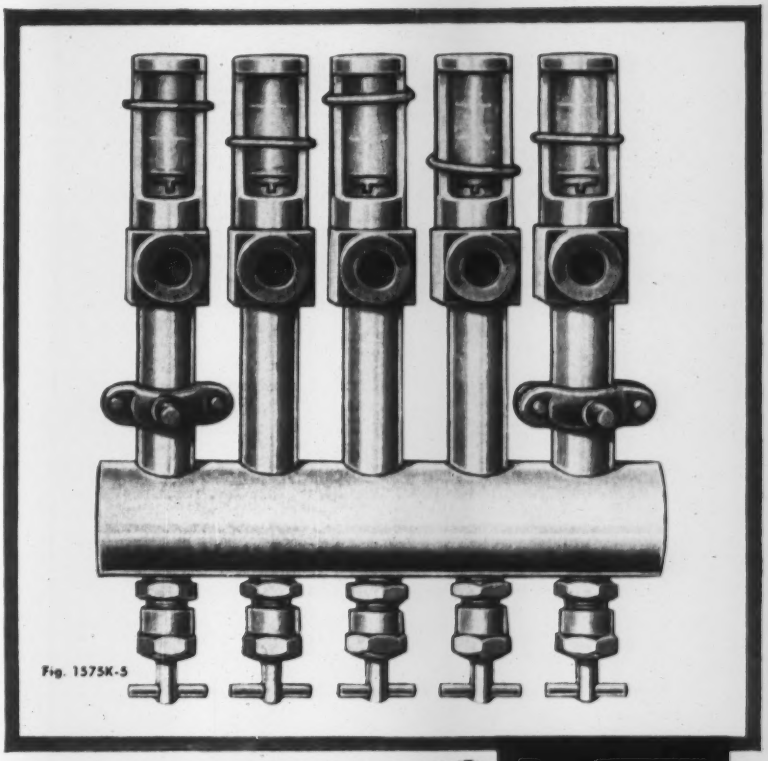
Fig. 1575K-5

NEW
. . from NUGENT
PRESSURE SIGHT FLOW LUBRICATORS

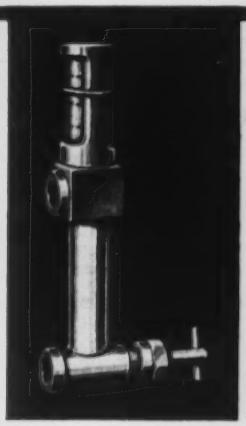
Fig. 1575

Now you can deliver lubricating oil or other liquids under pressure, in accurately measured quantities, to high or otherwise inaccessible points with the Nugent pressure sight flow lubricator. They are available as single units or in multiples to 15 depending upon the number of feeds required.

Each lubricator making up a multiple unit is capable of feeding fluid in amounts varying from several drops to two pints per minute by simple adjustment of the individual needle valves.

Single lubricators are available with 1/4" or 3/8" ips inlet and outlet. Inlet sizes of multiple units range to 3/4" ips with 1/4" or 3/8" ips outlets. All are designed for 125 psi maximum working pressure.

Write for complete details.

Established 1897
Wm. W. Nugent & Co., Inc.
3412 Cleveland Street Skokie, Illinois

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- Makes possible the immediate location of every fastener described with name and address of supply source.
- Relates actual uses of fasteners in one industry to those of another, resulting in concrete examples of money-saving applications.

FASTENERS HANDBOOK greatly facilitates the review of available information, the making of a valid selection, and contacting the sources of supply. It can be used by design engineers, patent attorneys, sales personnel, fastener distributors and jobbers—in fact, anyone who needs solid information on fasteners available for mechanical assembly.

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NEW EQUIPMENT
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Names Wheel Representative

Electro Refractories & Abrasives Co. has appointed Rex Tool Co., Inc., Milwaukee, specialists on tools and abrasives, to handle wheel sales in the Milwaukee vicinity.

New Office Building

Dynamatic Div., Eaton Mfg. Co., has started construction of a new office building at Kenosha, Wis., as the final phase of its $2,300,000 expansion program announced last year.

New Representatives

The appointment of two new sales representatives, the Henry Kalz Co., Portland, Ore., and Barber Machinery Ltd., Calgary, Alberta, Can., have been announced by Hamer Valves, Inc. Both firms will provide sales engineering assistance on the complete line of Hamer products, including the line blind and plug valves as well as a newly introduced leakproof gate valve.

LATEST CATALOGS

Hydraulic Review

Denison Engineering Div., American Brake Shoe Co., 1714 Dublin Rd., Columbus 16, Ohio, is offering its quarterly publication, Denison Press, for permanent mailing lists.

The current issue covers details on a new hydraulic pump for continuous 2000 psi service. Other sections cover various applications of hydraulic pumps.

Airborne Regulators

Waterman Engineering Co., 725 Custer Ave., Evanston, Ill., has issued an illustrated eight-page brochure presenting its new flow regulators for airborne equipment.

Diagrams and charts explain the principle of operation of these flow regulators. How they may be used to advantage in aircraft or in any product where a control of flow is necessary is graphically shown.

Boiler Bulletin

A 24-page illustrated bulletin, describing Powermaster packaged automatic boilers, is available from Orr & Sembower, Inc., Morgantown Rd., Reading, Pa.

The packaged automatic boiler comes equipped to operate on oil or gas or both. It is available in sizes ranging from 40 to 500 hp. It is recommended by the company for industrial plants, institutions, food industries, service industries, educational centers, hotels and apartments, business and office buildings.

ENGINEERS
Mechanical, Electromechanical

Information manual about APL and its programs now available

The Applied Physics Laboratory (APL) of The Johns Hopkins University is unique in that we are neither an industrial nor an academic organization, but rather a composite, having drawn freely from the methodologies of each.

For thirteen years APL has pioneered in guided missiles. Today we are engaged in a broad program of R & D for the Navy; in addition, we are responsible for technical direction of industrial and academic contractors in developing the Terrier, Talos and other major weapons and weapons systems. Our staff members enjoy not only the stimulus of association with their immediate colleagues at APL, but also with those in other organizations of considerable stature.

NEW 30-PAGE PUBLICATION

A few positions for senior engineers and scientists are now open. Information on our accomplishments and goals is available in a new 30-page publication, just off the press.

In it staff leaders representing each of the various disciplines and fields outline the nature of their programs. Information on our new laboratory in Howard County, Md. (equidistant between Baltimore and Washington) is also included, together with facts on the outstanding communities in which our staff members live.

Quantity is somewhat limited. May we suggest you send now to: Professional Staff Appointments,

The Johns Hopkins University
Applied Physics Laboratory

8607 Georgia Avenue, Silver Spring, Md.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

New Catalog

Philadelphia Gear Works, Erie Ave. & "G" St., Philadelphia 24, Pa., announces the issuance of a complete, new 40-page catalog on their Spiral-Bevel Speed Reducers. This modern book contains Design features, specifying and ordering information, Selection tables, Service factors and arrangements, Dimensions, Horsepower Ratings, Parts lists, etc. . . In fact, it is practically a "treatise" on the subject.

A copy of this Catalog SB-517 will be sent upon request on your Business Letterhead.

Mechanical Gap Presses

A 16-page catalog issued by Verson Allsteel Press Co., 9300 S. Kenwood Ave., Chicago 19, Ill., presents illustrations and detailed specifications of mechanical gap presses from 75 to 500 tons capacity.

Design details are included as well as photographs of gap press installations.

Water Treatment

North American Mogul Products Co., Standard Bldg., Cleveland 13, Ohio announces a bulletin, WDC, describing water treatment to reduce hard deposits, congestion and corrosion that decrease the efficiency of wet-type dust collectors and necessitate frequent clean-outs.

Case histories show how six manufacturing plants cut clean-out time and protect their equipment at low cost.

Surface Condensers

An illustrated bulletin, No. M-571, has been prepared by the Manufacturing Div. of Southwestern Engineering Co., 4800 Santa De Ave., Los Angeles 58, Calif. to describe its new line of surface condensers. It is designed for production of vacuum for prime mover service with large steam turbines. The units offer a new "Delta Vee" design.

Metalworking Coolant

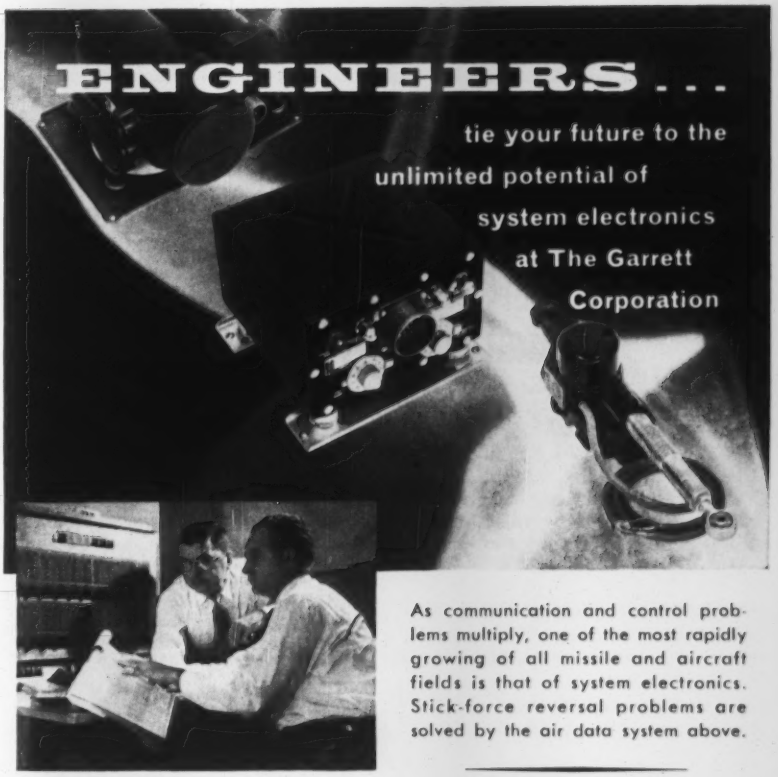
A liquid that acts as a coolant, lubricant and rust preventive when mixed with water is described in an eight-page booklet released by Harry Miller Corp., 4th & Bristol Sts., Philadelphia 40, Pa.

The booklet describes seven different ways the coolant, Hamikleer, cuts metalworking costs, Case histories, application data and details on a testing kit are included.

Welded Steel Tubing

A pocket-sized reference booklet containing recent information on commercial tolerances for welded steel tubing is being made available by Revere Copper and Brass Inc., Rome Mfg. Co., Div., Box 111, Rome, N. Y.

The booklet contains 14 pages of tolerance charts for cold rolled steel, hot rolled steel, cut lengths, rounds, squares and rectangulars and Revere propeller shaft tubing.



As communication and control problems multiply, one of the most rapidly growing of all missile and aircraft fields is that of system electronics. Stick-force reversal problems are solved by the air data system above.

- **TECHNICAL DEVELOPMENT ENGINEERS—ELECTRONICS** Graduate engineers required for preliminary design and analysis of electronic-mechanical systems involving closed-loop servos and low frequency amplifier circuitry. A mathematical background and experience with problem setups on digital and analogue computers are essential.
- **TECHNICAL DEVELOPMENT ENGINEERS—FLIGHT INSTRUMENTS & TRANSDUCERS** Graduate engineers required for preliminary design and analysis of small, precision, electro-mechanical, pneumatic devices involving bellows, diaphragms, cams, proportional pickoff sensors, pneumatic amplifiers, servo loops, etc. A mathematical background and experience with problem setups on digital and analogue computers are very desirable.
- **OPERATIONAL ENGINEERS** Graduate engineers for follow-on development of the above mentioned product categories. This work includes such activities as: laboratory circuit development of breadboards and prototype hardware, specialized test equipment design and construction, liaison with design drafting group, liaison with customer during initial equipment installation in aircraft, engineering instruction writing for inspection and production departments, and additional engineering functions necessary for establishing efficient production of the equipment hardware.
- **COMPONENTS ENGINEERS** Graduate engineers to act as consultants in matters of vendor contact on electronic and electro-mechanical components. These positions require experience in component testing as on potentiometers, capacitors, etc., and a knowledge of relative qualities and state-of-the-art of such components as manufactured by various vendors. Familiarity with military aircraft specifications desirable.
- **DRAFTING DESIGN ENGINEERS** Designers required for board work in originating packaging designs of electronic, electro-mechanical, and precision miniature pneumatic mechanisms.

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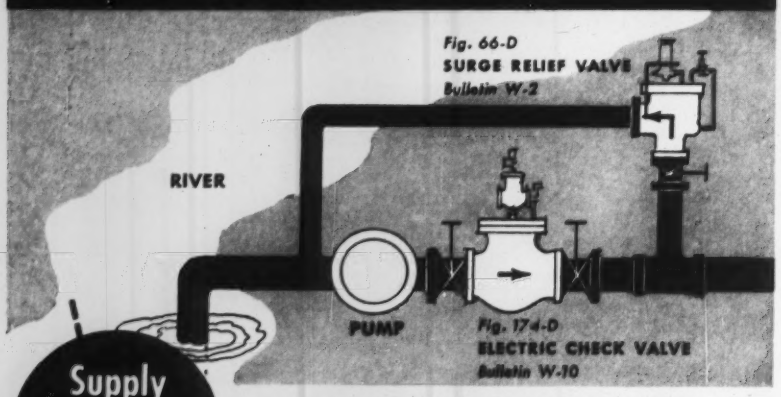

Supply water to mill or city

THE G-A SHOCK-TAMER TWINS

The G-A Cushioned Surge Relief Valve protects water lines against excessive surges in the system by automatically opening when the inlet pressure exceeds a predetermined setting.

The G-A Double Cushioned Electric Check Valve effectively prevents surge by opening only when pump comes up to speed, closing automatically with pump running and shutting down pump when 95% closed.

Check Valve Service Without Hammer or Shock

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Rolling and Flaring Tube Expanders—Sizes 1½" and up for all types of Fire Tube Boilers.

Write for New Bulletin "A"

(33)

The Gustav WIEDEKE Company

Dayton 1, Ohio

KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

Giant Crane

Morgan Engineering Co., Alliance, Ohio, has published an illustrated brochure giving complete technical data on design and capabilities of the world's largest ladle crane. The firm recently completed the second of three of these 500-ton giants for a new eastern steel mill. Its huge ladle will complete a 375-ton pour of hot metal in a single trip from furnace to mold. Control cage alone is three times as big as an average five room house.

Hopper-Feeder

A data sheet, Bulletin No. 569, covering its new elevating hopper-feeder has been issued by Gear-O-Mation Div., Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12.

The hopper-feeder is for use with parts that can roll or slide. The simple two-page data sheet has a large photo of the equipment on one page and has a complete description of its construction and application on the other side.

Power Reactor Systems

General Electric Co., Atomic Power Equipment Dept., Schenectady 5, N. Y., has announced a bulletin, GER-1384, reviewing reactor systems to produce commercially useful electricity from nuclear energy.

The bulletin presents a description of various systems using water, gas, sodium and liquid-fuel as coolants.

Turbo Cooling Systems

A 32-page brochure has been prepared by the York Corp., subsidiary of Borg-Warner, York, Pa., describing the company's single-stage Freon-11 turbo water cooling systems in capacities of 115–350 tons.

The three-color brochure contains cutaway diagrams of system components, charts of dimensions and weights of various systems, 12 pages of simplified selection tables giving typical rated capacities and engineering specifications for turbo water cooling systems.

Exhausters, Compressors

Bulletin 4P, released by Schutte and Koerting Co., Dept. JA-3, Cornwells Heights, Pa., describes the company's line of single-nozzle and multinozzle water jet exhausters, water jet laboratory vacuum pumps, and barometric hydro-vac exhausters for pump priming, handling air and evacuating vessels, and for mixing gases and liquids in continuous processes.

The bulletin includes application, construction, and operation information on each type exhauster manufactured and gives data on sizes available and dimensions. Capacity curves, capacity ratios, and water consumption tables are included.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Flow Chart

Hays Mfg. Co., Erie, Pa., announces a flow chart, Bulletin 237, featuring dimensional information and cross-sectional illustrations of a new special purpose flow rate control designated Flush-Flo backwash control.

Roller Chain, Sprockets

A 68-page catalog describing and illustrating the firm's line of stock roller chains and sprockets has been released by Diamond Chain Co. Inc., Dept. 413, 402 Kentucky Ave., Indianapolis 7, Ind.

How to select a stock roller chain drive, establishing service horsepower required and determining size of driven sprocket is covered in the catalog, No. 757.

Timing Motors

A four-page bulletin describes the line of high torque synchronous timing motors produced by E. Ingraham Co., Bristol, Conn. The bulletin contains dimension diagrams, specifications and characteristics of permanent magnet and hysteresis types. The motors are designed for original equipment application in the appliance, industrial and metalworking fields.

Valves, Controllers

A. W. Cash Co., Box 551, Decatur, Ill., has published a catalog on its Standard and Standard Stacon lines of pressure reducing and regulating, relief, back pressure and control valves; controllers; differential regulators; oil pumping units; governors; combination and temperature regulators.

Included in the 8-page catalog is a photograph of each unit, with descriptive copy covering its function, application, construction and range of sizes. Also included are several examples of complete control systems utilizing Standard units as components.

Polyvinyl Chloride Pipe

A 12-page two-color catalog available from Alpha Plastics Inc., 78 Okner Parkway, Livingston, N. J., describes the firm's regular and high impact corrosion-resistant rigid polyvinyl chloride pipe.

Included are tables of pipe sizes available, specific chemical applications, physical properties, temperature factors for various working pressures, support spacing and thermal expansion. Flow charts, installation instructions, pipe characteristics and fields of application also are included.

Use a CLASSIFIED ADVERTISEMENT

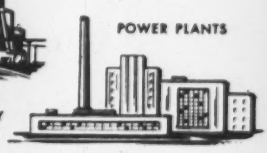
For Quick Results

Industry looks to

RESEARCH -COTTRELL

for high dust collection efficiencies

CHEMICAL PROCESS AND STEEL INDUSTRY



POWER PLANTS

To maintain visually clean stacks at all times, industry is turning to the long experience of Research-Cottrell in the design and manufacture of highly efficient Cottrell Electrical Precipitators. We've spent 40 years in solving such problems as nuisance abatement, cleaning gas for subsequent use and recovering materials of value. Write for illustrated bulletin describing a wide range of electrical precipitator applications.

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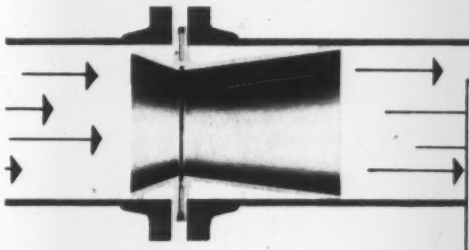
RC 137 *228 N. La Salle St., Chicago 1, Ill. • 111 Sutter St., San Francisco 4, Cal.*

NEW TYPE FLOW METER CUTS PRESSURE LOSS BY 93.5%*



***Here's How!**

Builders Dall Tube #12D in 12" pipeline — max. differential 80" — max. flow 3900 GPM. — Pressure loss at max. flow — 2" of water

Orifice plate in 12" pipeline for same max. differential and flow — Pressure loss at max. flow — 31" of water

Pressure loss saving with Dall Flow Tube — 93.5%

(On one installation, this saving produced pumping power cost reduction of $560.00 each year.)

Get low cost flow metering with **Builders Dall Flow Tubes** — the primary element with the lowest pressure loss of any velocity-increasing differential producer!

- Greater instrument accuracy through higher differentials at the lowest total head loss.
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- All critical surfaces precisely machined to Dall formulae.
- *Enduring accuracy through self-scouring, durable construction.*

CAST DALL FLOW TUBE RECOMMENDED FOR WATER WORKS AND SEWAGE INSTALLATIONS

Request Bulletin 115-DM1, from **Builders-Providence, Inc., 382 Harris Avenue, Providence 1, R. I.**

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DIVISION OF
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Pantex SPEEDYLECTRIC STEAM GENERATOR

Ideal Answer to
10 PROBLEMS
in Supplying Steam

- **Without flame, flues or stack**
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- **Without long steam lines**
- **To serve summer processing needs**
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- **Where boiler space is limited**

In many such situations, a Speedylectric Steam Generator is the best or only solution. Using the electrode method of generating steam electrically, completely safe anywhere, its design eliminates low-water hazard and practically removes the need for supervision. Generation is fast, by the simplest and most economical electric method, and adjusts automatically to meet load demand. Upkeep is nil . . . there are no coils, tubes or heating elements to scale or burn out. Sizes from 2 to 50 Bhp, 15 to 500 psi. Higher pressures are available. Electric power 220, 440, or 550 volts A. C. UL listed, ASME code.

FOR YOUR FILE

Send for Bulletin SG-100: operating principles, application features, detailed specifications for complete line.

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Send me Bulletin SG-100 . . . free

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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Titanium Fact File

Mallory-Sharon Titanium Corp., Dept. ME, Warren Ave., Niles, Ohio., announces a 24-page booklet describing the advantages, metallurgy, machining, welding, quality, properties, corrosion and forming characteristics of titanium.

Tables cover properties and corrosion resistance and photos and text deal with other basic data on this metal.

Cooling Tower Data

Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa., has released a new application engineering data sheet, D-57-1, describing methods of combating corrosion and delignification in cooling towers, using controlled volume pumps to meter precise quantities of chemicals to cooling water.

This sheet features details and drawings explaining continuous pH control using Mesemetric pumps, acid metered in proportion to flow rate, chemical feed with automatic level control and other low-cost cooling tower water treating systems.

Automatic Controls

Bulletin No. 1032, recently published by Copes-Vulcan Div., Blaw-Knox Co., Erie, Pa., describes the application of automatic control systems to large central station boilers.

Using as an example, the new Sutton Station of Carolina Power & Light Co., the bulletin explains the operation of the combustion, feedwater, feedpump and soot-blowing control systems. A schematic diagram shows how the individual components are integrated into complete supervisory systems for greatest simplicity. All controllers are of the modern plug-in type, and flow transmitters have friction-free transverters for pneumatic square-root conversion.

Radiant Heating

A brochure describing the various applications of radiant heating equipment in metal processing has been published by Fostoria Pressed Steel Corp., Fostoria, Ohio.

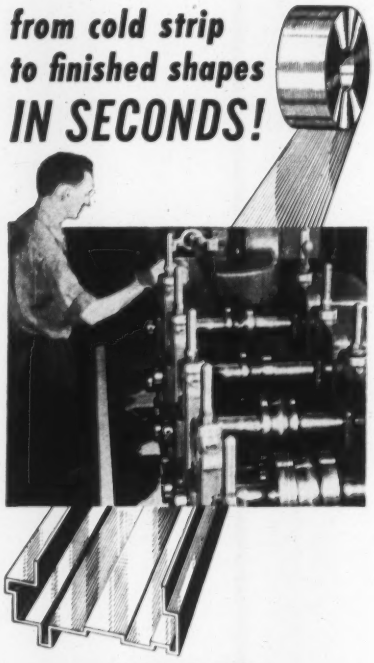
Eighteen applications are described in capsule case-history form. Data on product heating problems, processing temperatures, time cycles and oven design are included along with a description of the firm's four sources of infrared energy and where they are applied to metalworking heating processes.

Steel Sand Castings

Alloy Steel Casting Co., 249 County Line Rd., Southampton, Pa., has issued an illustrated brochure on its products and services.

The publication discusses the types and applications of the stainless steel sand castings produced by the foundry. Featured is a table listing specifications of some common stainless steel alloys.

from cold strip to finished shapes
IN SECONDS!



YODER ROLL-FORMING MACHINES

If you are in the business of manufacturing a product that is, or could be, made wholly or partly from flat rolled metals in thicknesses up to ½", a Yoder Roll-Forming machine can help reduce your production costs.

Cold-formed shapes of every description —including structurals, tubular products, moldings, trim, roofing and siding, panels, cabinet shells, etc., can be produced on Yoder cold-roll forming equipment at the rate of 25,000 to 50,000 feet per day at a conversion cost of only a fraction of a penny per foot! With speeds and costs such as this, even part-time operation of a Yoder roll-forming line is a profitable investment!

Additional operations such as welding, coiling, ring forming, perforating, notching, embossing or cutting to length can be simultaneously introduced to the basic shape at little or no additional labor cost. Yoder engineers are at your service in explaining the advantages of roll-forming for your individual needs.

A new, revised, Fifth Edition of the Yoder Cold-Roll Forming book is just off the press. In addition to economic and mechanical possibilities of cold-roll forming, it contains numerous illustrations of end uses and applications of roll-formed shapes. Write for your copy today.

THE YODER COMPANY
5499 Walworth Ave. • Cleveland 2, Ohio

YODER — COLD ROLL FORMING MACHINES

Clean, uniform, exact heat to match the size and shape of your production equipment

CHROMALOX

Electric Strip Heaters

Quickly and easily bolt or clamp Chromalox Electric Strip Heaters to your platens, dies, kettles, tanks, pipes, ovens, air ducts, for the many advantages obtained only with electric heat.

Lengths 4" to 96" Widths ¼" to 2½"
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7646 Thomas Boulevard, Pittsburgh 8, Pa.

C-2110A

KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Power Units

A four-page color brochure describing a new electric-hydraulic power unit and a new air-hydraulic power unit is available from Hi-Shear Rivet Tool Co., 2600 W. 247th St., Torrance, Calif.

The publication includes a description of features, photographs and flow charts for both units.

Electrical Steel

A revised Blue Data Sheet on electrical steel, 4750, is being distributed by the Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh 22, Pa.

The 20-page bulletin gives detailed information on this iron-nickel steel, including, typical physical, mechanical and magnetic properties. Sixteen graphs are included.

Nuclear Projects, Testing

Activities of the Nucledyne Corp., 2700 N. Southport Ave., Chicago 14, Ill., in recent nuclear radiation projects, automated testing, and environmental laboratory equipment fields, are described in a 16-page booklet released by the company.

The publication presents graphic examples of design, construction, and installation of specialized facilities for hypertechnical industries.

Rotary Piston Pump

An illustrated technical reference, No. Tr-57-A, describing a rotary piston pump for lubrication of vertical shaft machinery is offered by Bijur Lubricating Corp., 151 W. Passaic St., Rochelle Park, N. J.

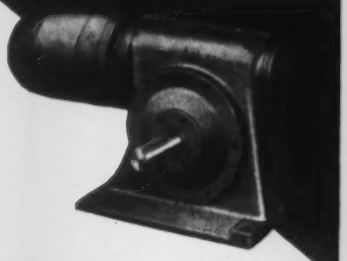
The sheet describes a sump pump for continuous flood lubrication of bearings and gears, which may be mounted on either lower or upper end of the machine shaft. In either application, oil is forced through an axial hole in the shaft, where it flows downward through bearings or gears. Paragraphs in the sheet discuss operation, capacities and typical mountings. Cutaway drawings and photographs illustrate the text.

Safety Shutoff Valves

A 12-page bulletin in color has been published by North American Mfg. Co., Cleveland 5, Ohio, describing its line of Series 22 safety shutoff valves.

The bulletin describes and illustrates the standard solenoid operated valve approved by FM, UL, and CSA; the four combinations of pressure holding devices which may be substituted for the solenoid; the special models for use in coke or other dirty gas lines, and the weatherproof model for outdoor service. The bulletin has capacity tables for both low and high pressure gas, and for oil.

D.O. James GEARMOTORS



RIGHT ANGLE GEARMOTOR — Horizontal or Vertical Drive, 8 sizes, ratio 6:1 to 100:1, ⅓ to 30 horsepower.

IN-LINE GEARMOTOR — Horizontal or Vertical Drive, 37 sizes, ratio 9.2:1 to 1200:1, 1 to 75 horsepower.

OUR 70th YEAR

THE D.O.James Gearmotors are of the same construction and high quality as the individual Gear Speed Reducers which we have been producing for so many years.

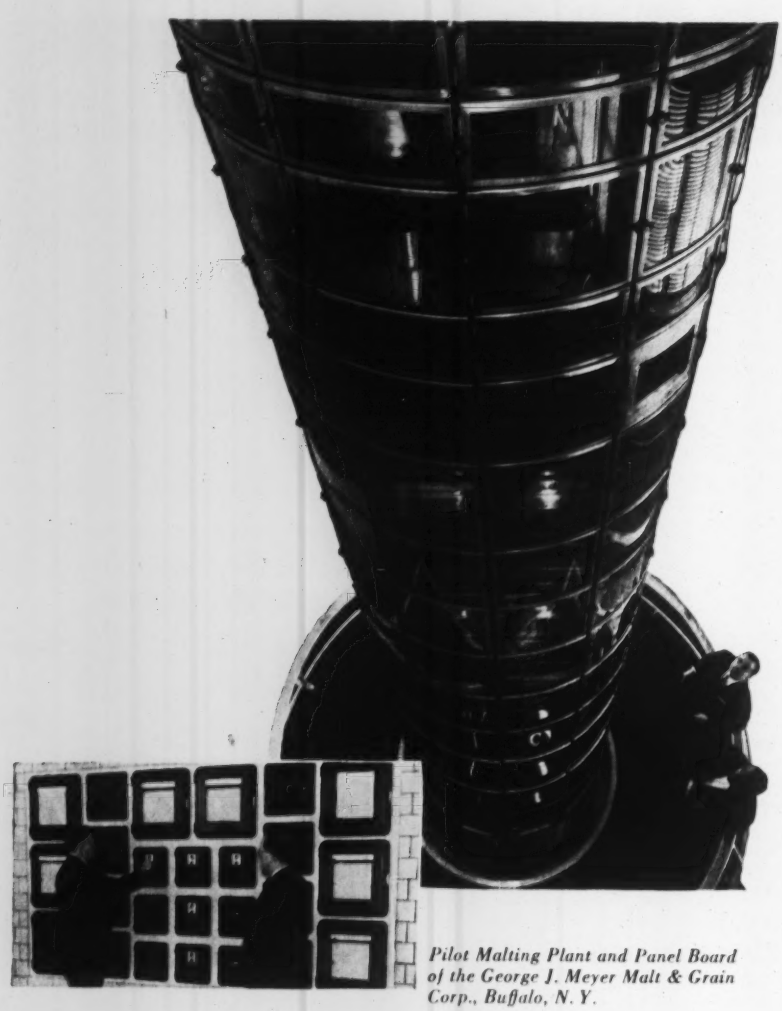
They cover a very wide range of ratios, horsepowers, and are an ideal, compact, efficient unit for many power and space-saving installations. They are designed and built by an organization that has been engaged in the manufacture of Gears for 70 years and that has successfully pioneered the Gear Speed Reducer to its present-day high standards.

D.O. JAMES
GEAR MANUFACTURING CO.
1140 W. Monroe Street, Chicago, Illinois

Since 1888
MAKERS OF EVERY TYPE OF GEAR AND GEAR SPEED REDUCER

SEND FOR CATALOGS

Catalogs, price lists and selection tables covering gear speed reducers and gearmotor speed reducers are available to power transmission engineers. Please request on company Letterhead — we'll mail your copy at once.



Pilot Malting Plant and Panel Board of the George J. Meyer Malt & Grain Corp., Buffalo, N. Y.

Important data for malting research recorded on TECHNICAL CHARTS!

This tower-like pilot malting plant is completely automatic, with more than 50 miniature valves, gates, dampers and similar devices. During research on the 10 day cycle of converting barley to malt, variables of temperature and moisture are accurately recorded at 42 points on TECHNICAL strip charts.

Research scientists as well as production engineers the country over rely on the accuracy found in every TECHNICAL chart. They also appreciate TECHNICAL'S ability to supply charts for **all** their instruments, regardless of "make". If you are not already a user, join the thousands who are by specifying TECHNICAL.

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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

Hex-Socket Screws

A new bulletin, Stainless Steel Data, has been issued by Allen Mfg. Co., Hartford, Conn., manufacturers of hex-socket screws and related products.

The 16-page bulletin covers characteristics of the three major types of stainless steels, together with their advantages in various kinds of applications. A section is devoted to special metal finishes and treatments available on stainless steel hex-socket screws.

Air Chuck Catalog

A catalog published by Cushman Chuck Co., Hartford, Conn., describes the company's line of air operated chucks, cylinders and accessory equipment.

The catalog is divided into seven sections, each of which is step-cut to provide a reference to chuck or cylinder descriptions, dimensions, part lists, accessories, general information and other products.

Centrifugal Castings

A catalog issued by Sandusky Foundry & Machine Co., Sandusky, Ohio, offers information on custom-made centrifugal castings in more than 70 different alloys including stainless steels, plain carbon and low alloy steels, monels, cupro-nickels and copper base alloys, and in sizes ranging from 7 to 54 in. OD. The castings, made to customer's specifications, can reach lengths as great as 33 ft, depending on diameter.

Resistance Alloy

An eight-page illustrated catalog describing an improved Copel copper-nickel resistance alloy developed for use on cold resistor applications in electronic devices, precision instruments and similar apparatus where mechanical stability and a known low coefficient of resistance are required, is announced by Hoskins Mfg. Co., 4445 Lawton Ave., Detroit 8, Mich.

The booklet, M-56C-N, contains specifications and price information on the 54 wire sizes and 31 ribbon sizes offered as standard.

Also included is basic technical information, a comparison of physical properties, plus tables giving the ohm-per-foot, and feet-per-pound for each of the standard wire and ribbon sizes.

Valve Bulletin

Conoflow Corp., 2100 Arch St., Philadelphia 3, Pa., has just issued a new bulletin describing the company's line of air-operated Saunders patent-type valves.

Bulletin HB-6 gives construction details and operating characteristics of Series HB valves. The booklet also includes sizing data and a listing of flow co-efficients to aid in the proper selection of valves.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

General Service Pumps

A four-page, two-color catalog No. E-100, describing the company's line of redesigned general service pumps is available from Economy Pump Div., of C. H. Wheeler Mfg. Co., 19th and Lehigh Ave., Philadelphia 32, Pa.

The pumps, designated as Type EUG, are used to drain boiler pits, scale and elevator pits, and other areas requiring the removal of solid-free drainage and seepage from low to high levels. Inside the brochure is a large cutaway drawing of a typical pump, with details of 17 construction features. The bulletin also contains metallurgy information, general data on performance and sizes, and details on pump accessories.

Heater Hook-Ups

An eight-page bulletin containing various hook-ups of electric heaters and heat-requirement nomographs for storage tanks handling viscous fluids has been prepared by Hynes Electric Heating Div., Turbine Equipment Co., Mountainside, N. J.

The fluids covered include fuel oil, asphalt road oils, molasses, tallow, animal fats, sodium and sulphur. Hook-up schematics and installation photographs show how electric heaters of any size, ranging up to 600 kw or more, can be installed in storage tanks of different sizes, types and services.

Aircraft Fasteners

Precision aircraft bolts incorporating the Nylok locking insert are described in a new bulletin offered by the Aircraft Products Div., Standard Pressed Steel Co., Box 558, Jenkintown, Pa.

The locking insert is a compressible nylon pellet that keeps threaded fasteners locked in place even under severe vibration and eliminates the need for wire fastening, lock washers or adhesives, the firm explains. The 16-page illustrated bulletin covers a complete line of standard and special aircraft bolts produced by the firm and its subsidiary, Cooper Precision Products. Included are alloy steel and titanium flush head, 6-digit, internal wrenching and 12-point external wrenching configurations—all meeting military specification MIL-F-18240A.

PAST EXAMINATIONS

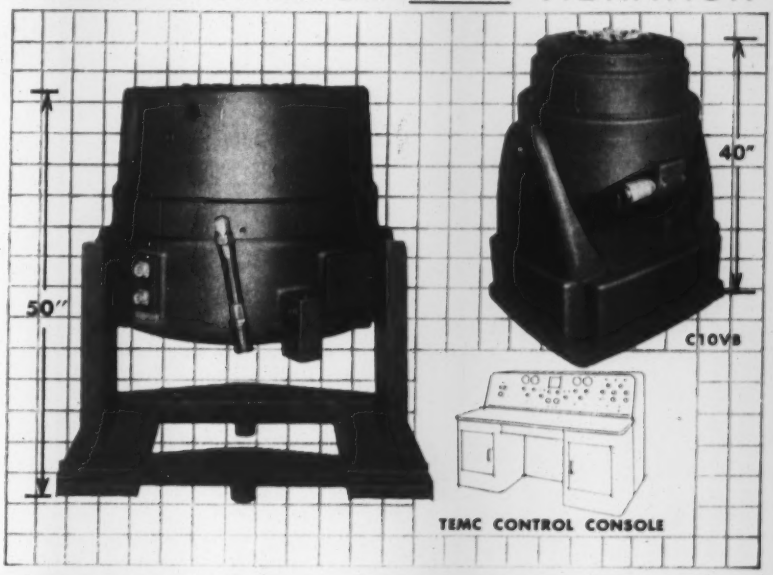
for Professional Engineers given by New York State

This pamphlet contains the questions given in 1952–1956 examinations. They cover problems in structural planning and design, in practical applications of basic engineering sciences, and the more advanced and specialized problems in practical applications of engineering principles and methods.

$2.00 (20% Discount to ASME members)

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
29 W. 39th St., New York 18, N. Y.

FIGHT VIBRATION WITH VIBRATION



Vibration Testing cuts product development time

Testing components and structures with electrodynamic vibration exciter systems cuts research and development time in aircraft and missile systems. Often within hours, or minutes, the effect of service vibration can be pinpointed.

MB has perfected shaker systems that permit testing to all required specifications, enable engineers to speed product development from blueprint to prototype to production.

COMPLEX MOTION TESTING

Several MB Exciter Systems reproduce complex and random motions. They can subject products to the actual service vibration. The Model C10VB Shaker shown offers the widest frequency range for its force. Model C25HB provides higher forces for higher "g."

ENVIRONMENTAL TESTING

Both the above shaker systems can be used with environmental chambers . . . for "high altitude" and high or low temperature vibration testing. Oil cooled, they don't affect chamber vacuum.

SPECIFICATIONS

MB C10VB System provides . . .
10 "g" on table loads to 145 lbs.
20 "g" on table loads to 57.5 lbs.

Force output:	Band width:
1750 lbs. Sine	5-5000 cps
1050 lbs. RMS	15-2000 cps
3150 lbs. Peak	15-2000 cps

MB C25HB System provides . . .
10 "g" on table loads to 422 lbs.
20 "g" on table loads to 172 lbs.

Force output:	Band width:
5000 lbs. Sine	5-2000 cps
3500 lbs. RMS	15-2000 cps
10,500 lbs. Peak	15-2000 cps

In meeting your requirements, MB offers you advanced designs . . . plus quality construction of shaker, amplifier and control system . . . plus an experienced field service organization.

MB manufacturing company

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1074 State Street, New Haven 11, Connecticut

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KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

Blind Rivets

A 10-page illustrated two-color catalog describing the company's line of pull thru and self-plugging blind rivets is available from Huck Mfg. Co., 2480 Bellevue Ave., Detroit 7, Mich.

The catalog lists the advantages of the two types of blind rivets and illustrates a number of typical applications with cross-section drawings. Among the technical data provided are material specifications, recommended hole sizes and shop practice notes. Dimensions, grip ranges and tolerance for both blind rivet types are also included.

Materials Handling

The right truck and attachment for practically every mechanical handling application is covered in a 12-page condensed guide of industrial trucks and attachments prepared by Hyster Co., 2902 NE Clackamas St., Portland 8, Ore.

The book covers the firm's line of basic truck models. The lift truck line includes cushion-tired models from 3000 to 5000 lb capacity and pneumatic-tired units from 1000 to 20,000 lb capacity. Other trucks include the mobile type crane with a maximum load capacity of 10,000 lb at 30 in. reach, straddle truck carriers of 20,000 and 30,000 lb capacity, an industrial tractor and a freighter platform truck.

Selection Survey Form

A selection survey form, designed to provide a means of selecting the most suitable boiler for a particular application, is available from Orr & Sembower, Inc., Reading, Pa.

The six-page survey is designed to make it possible to check on all the conditions requiring attention for a successful boiler installation. It is designed to provide information on the electrical supply, type of fuel to be used, boiler room size, special components or openings, boiler feed water, noise control steam requirement estimate, and special instructions.

Hydraulics Test Machine

Brochure HA-100 describing the operation of a newly designed universal hydraulic accessories test machine has been issued by Greer Hydraulics, Inc., N. Y. International Airport, Jamaica 30, N.Y.

The machine is designed for functional and operational testing of all types and sizes of aircraft and industrial hydraulic components such as valves, actuators, regulators, plumbing, tube and hose lines, manifolds, hand pumps and other hydraulic accessories. By simulating actual flight or operating conditions, the test machines are claimed by the manufacturer to measure accurately operation and performance of hydraulic components to meet the most rigid specifications.

Dust Control Bulletin

A new product bulletin describing the type W Roto-Clone, a dynamic precipitator, has been released by American Air Filter Co., Inc., 215 Central Ave., Louisville, Ky. The 16-page bulletin explains the Type W's distinguishing feature, the addition of a water spray to the basic principle of dynamic precipitation. The spray maintains a flowing film of water on collecting surfaces which lowers the water requirements to a minimum; traps even the lightest and finest dust particles; and delivers collected dust in slurry form for easy disposal.

New Rust Remover

An illustrated four-page folder describing a chemical compound that removes rust, paint and primer from metal surfaces in two steps without the use of acids, has been released by Turco Products, Inc., 6135 S. Central Ave., Los Angeles 1, Calif.

The product is said to eliminate six of the eight steps required by conventional methods of rust and paint removal. Parts being derusted by the new process are merely immersed into the hot solution and then rinsed. The compound strips slightly pitted rust in less than a minute. Heavy rust and multiple paint layers usually require only a few minutes immersion, it is reported.

If your VACUUM or PRESSURE requirements are in this range...

Vacuums to 27" Hg.
Pressures to 20 psig.
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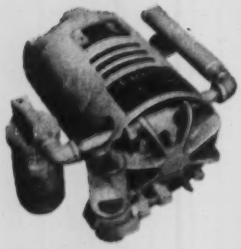
3.6 to 7.2 c.f.m.

...save space — simplify mounting—eliminate troubles —improve operation with



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MODEL K. 3.6 c.f.m. ⅓ hp. 13½" long—12" wide—7" high
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Patented Leiman feature adjusts automatically, pushes steel wings into contact with cylinder wall, assures constant seal, prevents wings from sticking or binding.

FEATURES INCLUDE: Steel wings for long wear—automatic wing adjuster—ball bearings—automatic oiler—fan cooling—noiseless operation—automatic thermal overload protection for motor—inlet filter and outlet separator—oil-free air. Plus—famous Leiman dependability and lifetime performance.

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Standard sizes for ⅛"- ¼"- ⅜"- ½"- ¾" pipe sizes.

Write for details in Bulletin KK-657, **THE AIR-MAZE CORPORATION**, Cleveland 28, Ohio. Department ME-9.

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When you specify TUBE-TURN* products, you are sure of getting the exact fittings for your job because the Tube Turns' line is the world's most complete . . . *you save engineering time.* Your welders can work faster because fittings are completely identified and perfectly uniform . . . *you save construction time.* You can buy all your fittings with one order from your nearby Tube Turns' Distributor . . . *you save purchasing time.* Are *you* getting these savings in piping costs?

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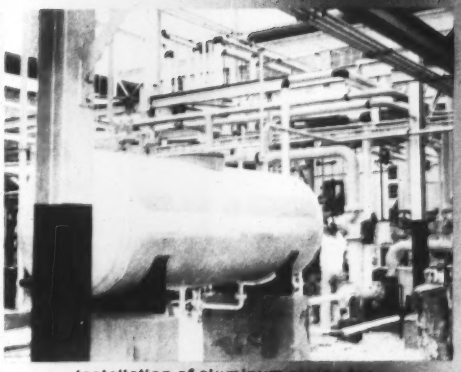

Installation of aluminum piping for handling ammonium nitrate.

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OTHER APPLICATIONS SHOWN ON REVERSE SIDE ▶

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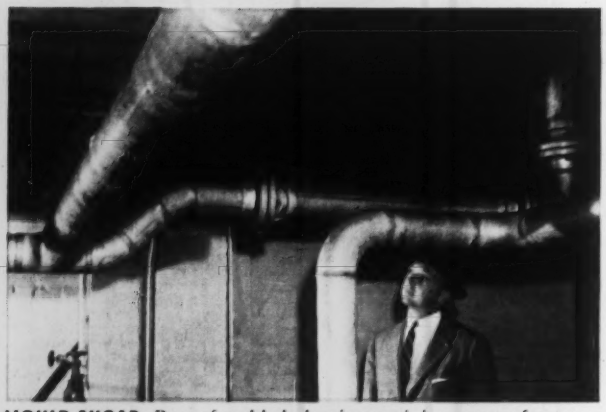
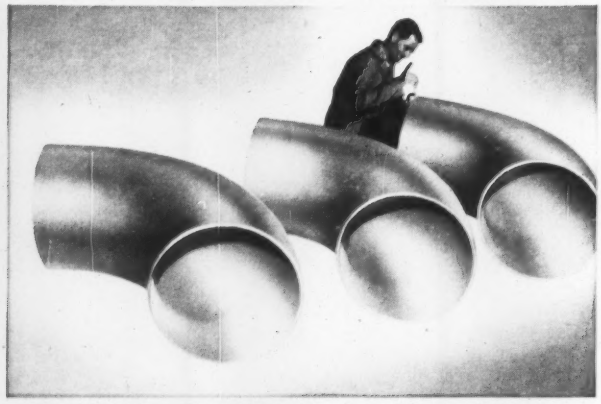
You save manhours with the line of 12,000 TUBE-TURN products



LIQUID SUGAR. Part of welded aluminum piping system for processing of liquid sugar. When you specify TUBE-TURN* products, you can count on getting the right type, size, schedule and material for every piping service. Saves engineering manhours.



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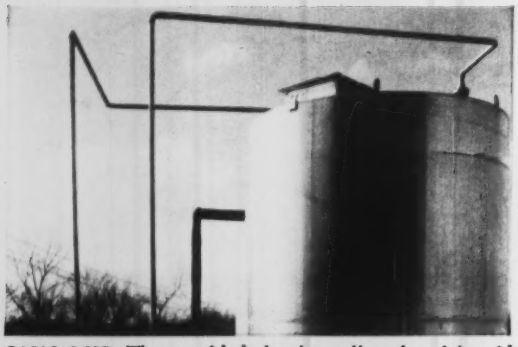

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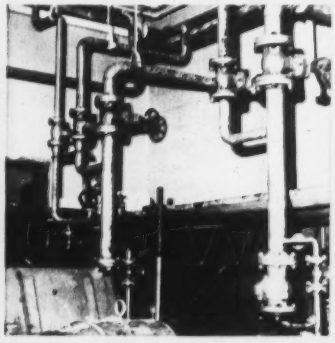
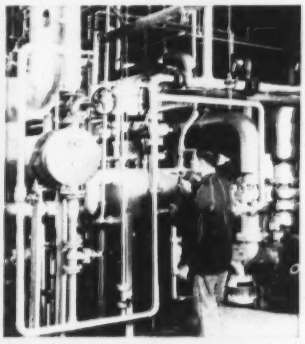


REFINERY CATALYST is handled by this aluminum piping, equipped with TUBE-TURN welding fittings and flanges. Uniformity of TUBE-TURN products saves construction manhours



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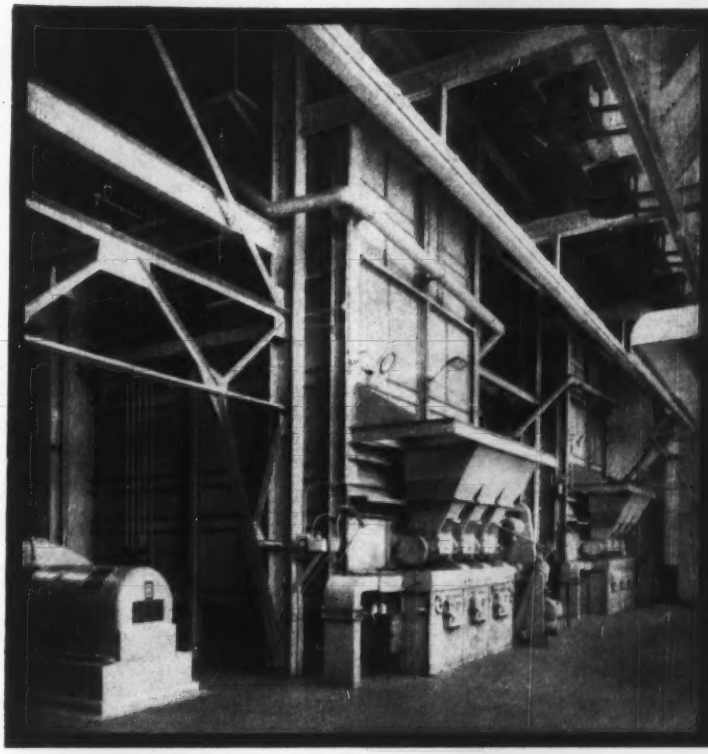

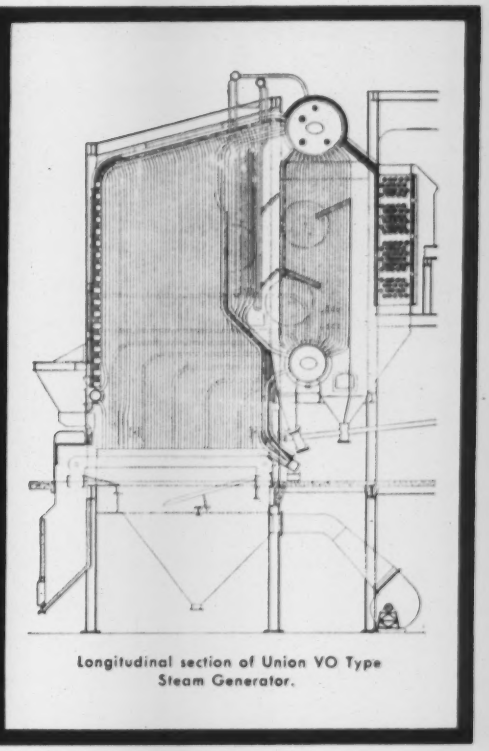

Longitudinal section of Union VO Type Steam Generator.

Union Boilers score new high at Notre Dame with 83% efficiency

Spread over a 1700-acre campus near South Bend, the University of Notre Dame is a self-sustaining community of 6,000 students and 500 faculty members.

To meet the demands of increasing enrollments, as well as to handle its own power requirements, the University expanded its steam heating plant and converted it to a steam-electric power plant. Three of the four original boilers were replaced with a pair of Union 2-drum VO Type Steam Generators. Spreader-stoker fired, each unit is equipped with a superheater and an economizer. Normal rating is 70,000 lbs./hr. at 470 psi and 750° F.

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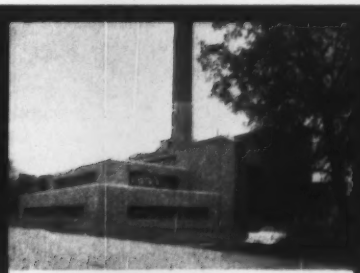
GET FULL DETAILS

Information on the several types of steam generators built by Union is yours for the asking. Write for illustrated Catalog GB-153.

Aerial view of Notre Dame — with 75 buildings on a 1700-acre tract, this campus is a city in itself.



Steam-electric power plant makes campus community independent of outside power sources.

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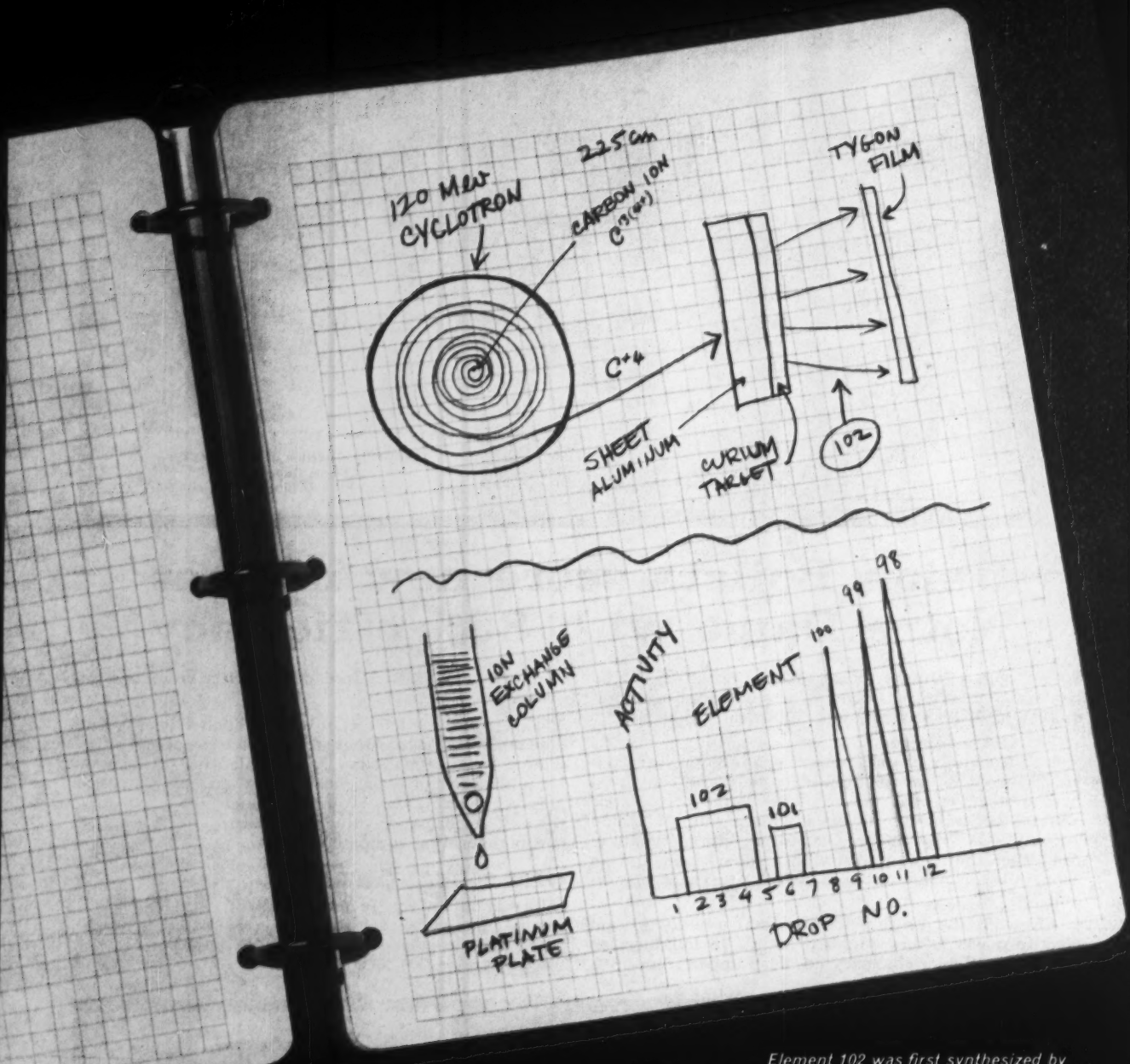

Element 102 was first synthesized by Argonne scientists Paul Fields and Arnold Friedman and colleagues; John Milsted of Harwell, England, Hugo Atterling, Wilhelm Forsling, Lennart Holm and Bjorn Astrom of Nobel Institute, Sweden

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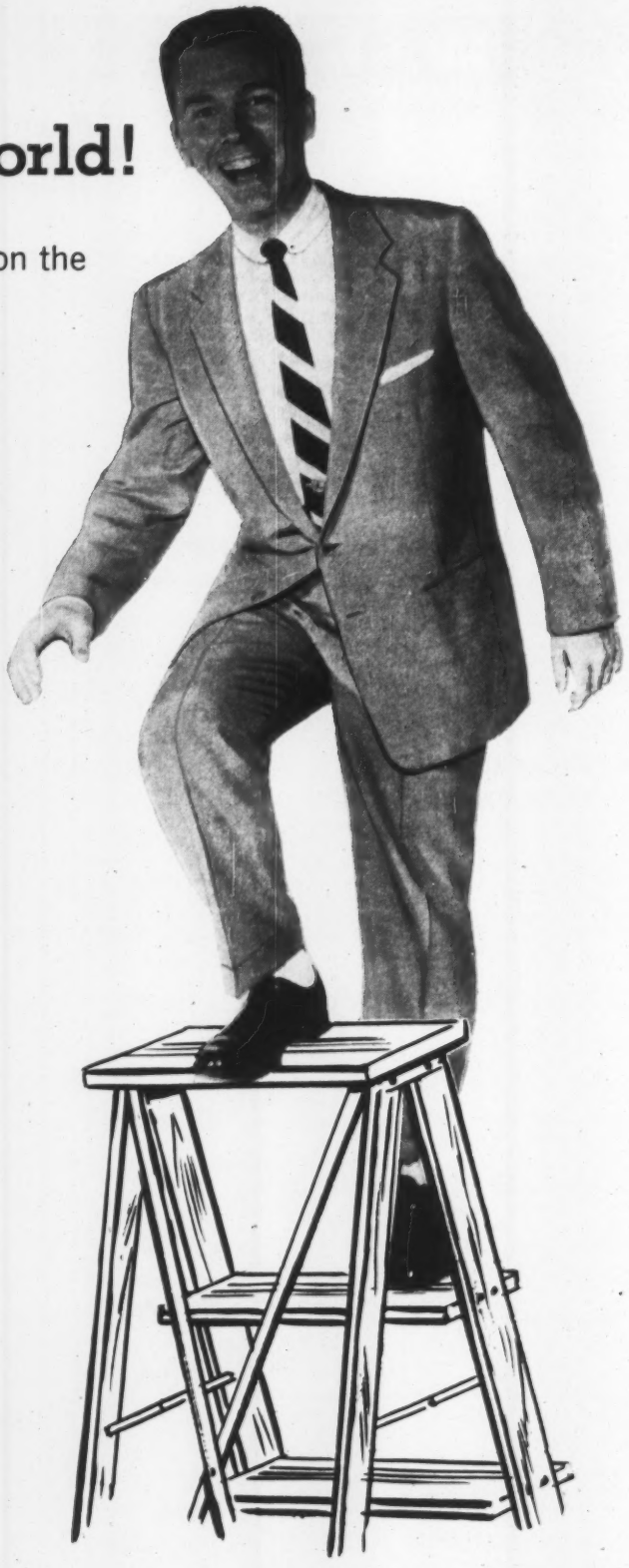

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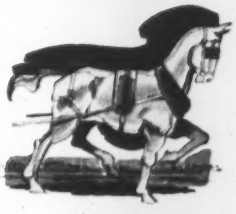

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As a "work horse," Rex Chabelco operates most efficiently in the slow to moderate speed range. Their pitch is longer than chains designed for higher speed service and, within its range, Chabelco assures lowest cost per dollar of h.p. transmitted. They can be used with cast tooth sprockets, an important cost-saving advantage.

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THE American Society of Mechanical Engineers promotes Mechanical Engineering and the allied arts and sciences, encourages original research, fosters engineering education, advances the standards of engineering, promotes the intercourse of engineers among themselves and with allied technologists; separately and in cooperation with other engineering and technical societies, and works to broaden the usefulness of the engineering profession.

As a post graduate school of engineering, the Society brings engineers into contact with each other, with leaders of thought and with new developments; it fosters the interchange of ideas, develops professional fellowships, and encourages a high standard of professional conduct—all with the purpose of advancing civilization and increasing the well-being of mankind.

C. E. Davies, Secretary
The American Society of Mechanical Engineers
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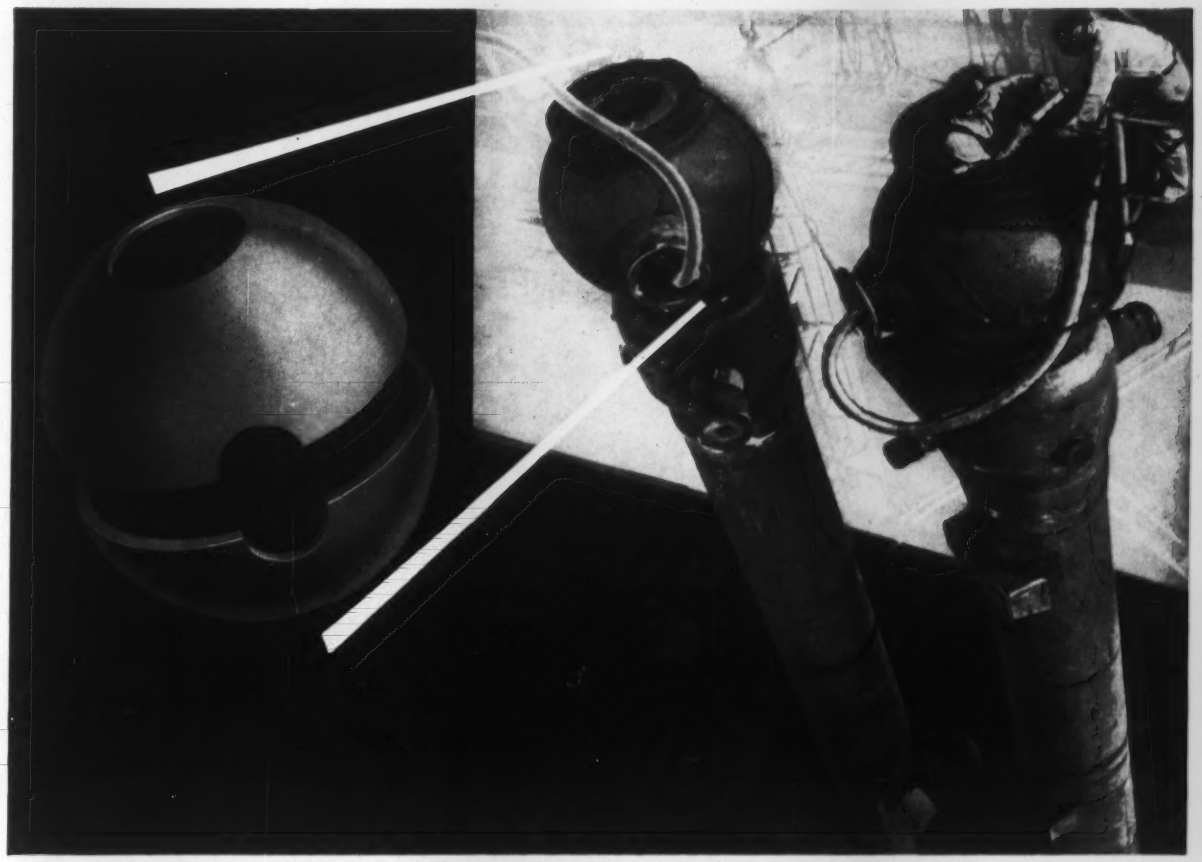


Imaginative use of Lukens heads brought new efficiency to fabrication and operation of these Braun spherical head feedwater heaters.*

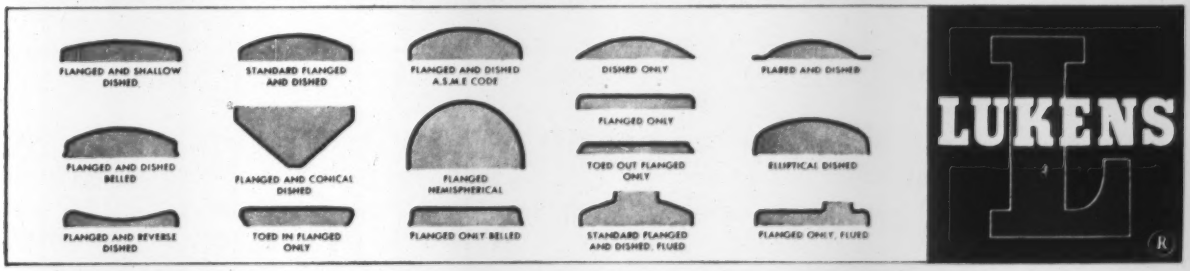
Now you can simplify . . . and save . . . designing with Lukens heads

Here's practical imagination at work—C. F. Braun & Co.'s new spherical head feedwater heaters.* Each sphere is fabricated from two Lukens standard hemispherical steel heads. The benefits: High reliability . . . elimination of all flanges and bolted gasket joints . . . the ideal simple shape for economy of material and fabrication.

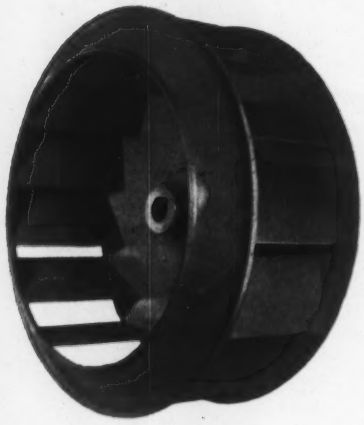
Fabricators of heavy and light machinery, valves, wheels, to name a few, have also benefited from imaginative use of Lukens heads. They've lowered costs, improved quality, streamlined fabricating methods. Lukens' fifty-five years as the leading producer of spun and pressed steel heads for many applications are at your service. Write for Catalog 931, *"Pricing and Engineering Data."* Lukens Steel Company, Coatesville, Pennsylvania.

*Patents Pending

Lukens Offers the World's Broadest Line of Spun and Pressed Heads of Carbon, Alloy and Clad Steels



The Sirocco Wheel—Designed with a multiple number of narrow, curved blades, forward pitched. Operating at low rotative and peripheral speeds, it delivers more air per revolution than any other type of fan.



The HS Wheel—Medium-speed wheel with true non-overloading power characteristic; features large-area die-formed blades, mounted in backwardly inclined position between heavy-duty backplate and streamline rim.

Match the wheel to the job . . . with rugged, quiet American Blower Sirocco and HS Fans!

American Blower fans have Certified Ratings for dependable performance.

American Blower's complete line of fans lets you match the wheel to the duty, whether it's ventilating, air conditioning, heating; or drying, fume-removal, and processing systems. Their heavy-duty design and construction assure you of long fan life with a minimum of maintenance. Take the Sirocco and HS fans, for example:

Sirocco and HS fans offer smooth, quiet air delivery, high operating efficiency and dependable service. They are available in 25 standard sizes from 12¼" to 132" wheel diameters for volumes to over 700,000 CFM.

Precision-built Sirocco and HS fans can be specified in single or double inlet and in any of eight standard discharges, with ball, roller or sleeve bearings as required. Inlet vanes, dampers or Gyrol Fluid Drive can be furnished to meet volume control requirements. Larger sizes are designed so that they can be dismantled for easy handling in shipment, erection and maintenance.

Get details on the complete line of American Blower fans. Call our nearest branch office; or write direct to American Blower Division of American-Standard, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

AMERICAN BLOWER

Division of **AMERICAN-Standard**

If it's BLUE-dyed Asbestos

YOU CAN BE SURE IT'S FLEXITALLIC

In every asbestos-filled Flexitallic Gasket, the blue dye in the Canadian asbestos filler provides positive product identification. When you see Flexitallic Blue, you can be sure it's a genuine Flexitallic Spiral-Wound Gasket . . .

- the original spiral-wound gasket made exclusively by this Company since 1912.
- constructed to meet specific conditions of thermal and mechanical shock, vibration, weaving and other joint stresses.
- flexible and resilient, self-adjusting to changes in operating conditions—affording greater safety, dependability, and long service life.

In every field of high-pressure seal, look for Flexitallic Blue. It's for your protection.

FLEXITALLIC GASKET CO.
8th & Bailey Sts., Camden 2, N. J.
Representatives in principal cities

Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

* Flexitallic is a registered trade name. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue* — it's our exclusive blue-dyed Canadian asbestos filler.

Jules Verne's "Nautilus" In 1870 one of the greatest science-fiction writers dipped into his imagination and created a fantastic submarine for his classic "Twenty Thousand Leagues Under The Sea". This unbelievable vessel was shaped like a cigar, 232 feet long, and could cruise at terrific speed to all parts of the world. It was called the "Nautilus".

Engineers! Turning Fancy Into Fact Is A Westinghouse Tradition

85 years later, Westinghouse actually turned this thrilling fancy into fact. On January 17, 1955 a modern "Nautilus" cruised down Connecticut's Thames River into Long Island Sound to start her sea trials. Powered by a history making nuclear engine, its exploits surpassed even the creation of Jules Verne's prolific imagination. For the first time controlled nuclear fission had successfully provided the motive power for a vehicle or vessel.

ENGINEERS — ***Westinghouse is now engaged in building the world's first atomic powered fleet. If your background includes pump, valve, or arrangments experience, join our atomic team in this historic undertaking.***

U.S.S. Nautilus

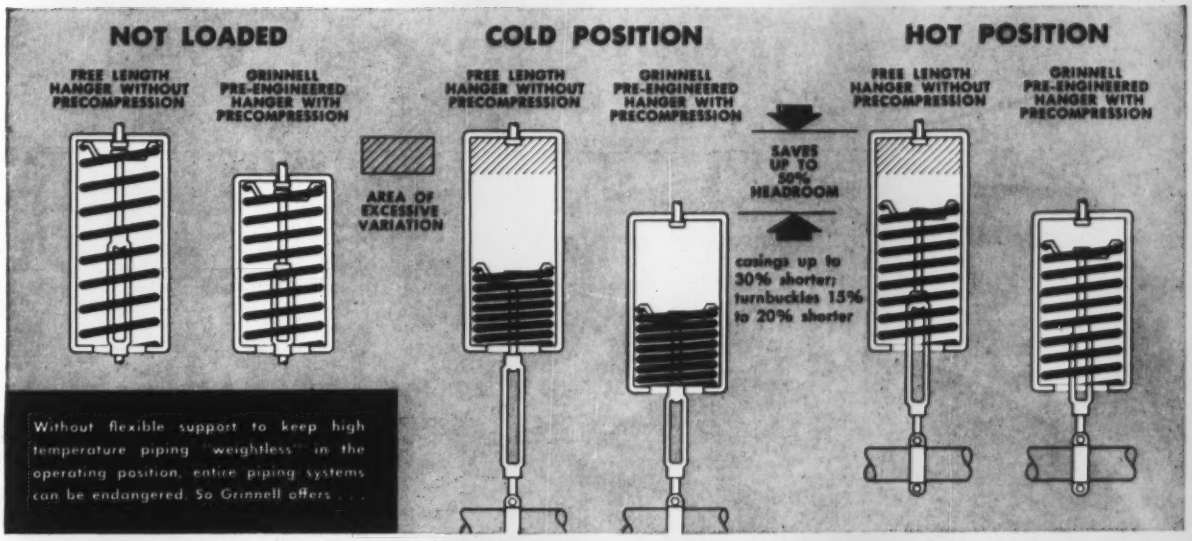
Powered by the "S2W" Atomic Engine, created and built by Westinghouse.

Submit your resume to:
Mr. John D. Batey

Westinghouse
ELECTRIC CORP.

First in Atomic Power

Dept. M-2, P.O. Box 1047, Pittsburgh 30, Pa.


NOT LOADED
COLD POSITION
HOT POSITION
FREE LENGTH HANGER WITHOUT PRECOMPRESSION
GRINNELL PRE-ENGINEERED HANGER WITH PRECOMPRESSION
AREA OF EXCESSIVE VARIATION
SAVES UP TO 50% HEADROOM
casings up to 30% shorter; turnbuckles 15% to 20% shorter
Without flexible support to keep high temperature piping "weightless" in the operating position, entire piping systems can be endangered. So Grinnell offers . . .

Precompressed Hangers for Safer Support of Piping

Helical coil springs are widely used in hangers for flexible support of piping which moves up or down during thermal expansion. The A.S.A. code for pressure piping requires that variable spring hangers support at least a minimum of 75% of the pipe's weight for a pipe that rises (relaxing the spring) and no more than 125% of the pipe's weight for a pipe that lowers (compressing the spring) during operation.

Precompression patented Grinnell principle

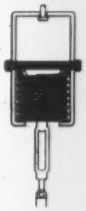
To guard against the spring's supporting force exceeding the limits of variation, Grinnell developed and patented a variable spring hanger design. The steel casing holds the spring permanently precompressed, at the threshold of the hanger's working load range. This prevents the spring decompressing into its area of excessive variation.

Pre-set is not a substitute

As a partial substitute for this patented precompression, some manufacturers insert a spacer between the top end of a free-length hanger casing and the spring to hold the spring's height temporarily within the working range during shipment and erection.

Another device requires the manufacturer to drill symmetrically opposite holes in the casing walls and insert a bolt to hold the spring's height within the working range. When these devices are removed from the hanger and discarded, the spring can decompress, resulting in high variability in supporting force.

Cold-setting a universal factory service

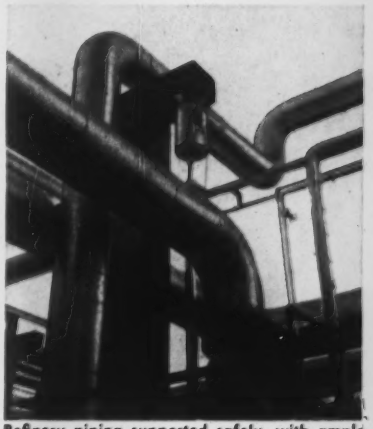


For the erection crew to avoid having to compress the spring down to the erected position, the manufacturer can compress the spring down to this height. Grinnell can provide a cold-set bolt in precompressed hangers.

Less headroom required by Grinnell Hangers

Shorter hanger casings made possible by Grinnell's patented precompression, reduce bulk shipping weight and required headroom by eliminating undesirable height. Installation is simplified by this shorter casing and also by an integral load scale with load indicator.

Additional headroom is saved by a correspondingly shorter turnbuckle. These precompression advantages are available in short spring and double spring models as well as standard spring models.



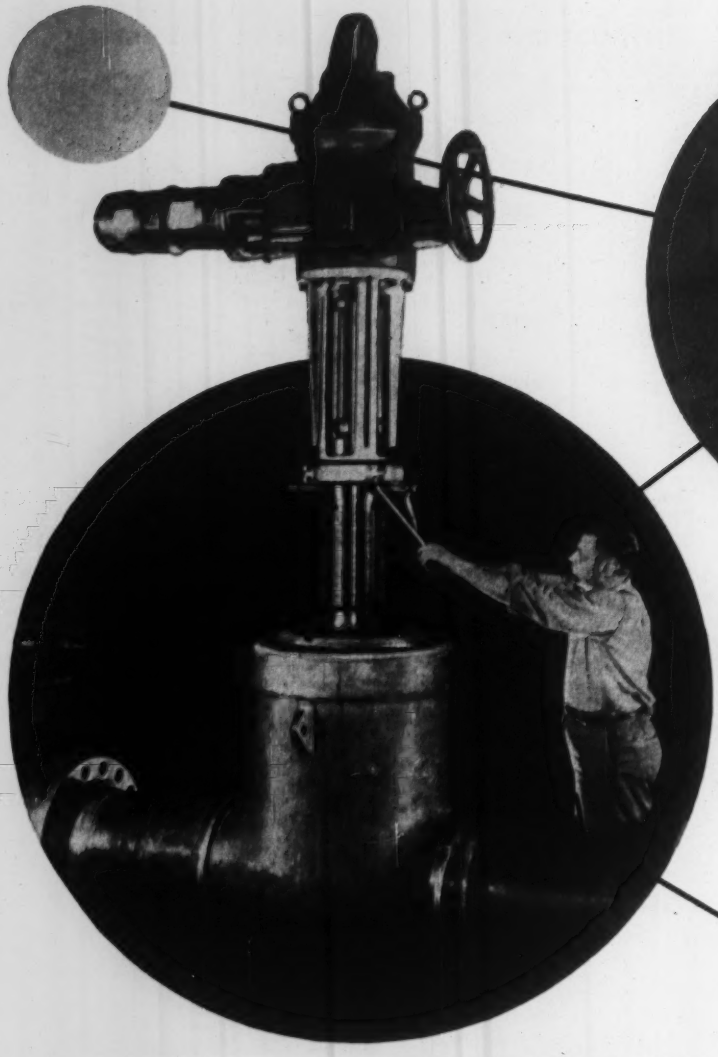
Refinery piping supported safely, with ample flexibility but low headroom.

Available in 63 standard units

Grinnell Variable Spring Hangers are available in 21 sizes each of short, standard and double spring models . . . for maximum travel of 1¼, 2½ and 5 inches respectively within working load ranges. Load capacities extend from 43 lbs to 30,550 lbs. The maximum variation in the standard size per ½-inch deflection is 10½% of rated capacity; inversely proportional in short spring and double spring models.

For further information

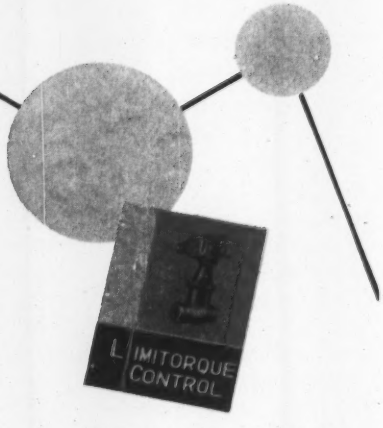
If you have a pipe suspension problem, you are invited to write: — Grinnell Company, Inc., 254 West Exchange Street, Providence, R. I.



in one of first land-based ATOMIC POWER PLANTS

LimiTorque

will operate special 18" Flow Control Valves



Shown above is the prototype of the special 18" Main Coolant Valves used at the Shippingport, Pennsylvania Plant of the Duquesne Power & Light Co. There are eight similar Crane Stainless Steel Parallel disc Gate Valves used on the Coolant lines in a pressurized water reactor system; and several will be opened and closed electrically by LIMITORQUE "push-button" Valve Operators. These valves are designed to seat and back-seat at pre-determined fixed loading. Special dial indicators are provided for continuous observation of seat-loading.

. . . Many other critical valves in this plant will be operated by standard Limitorque Valve Controls.

If standard Limitorque designs will not fulfill a special valve requirement, Limitorque engineers are prepared to solve your most difficult problems of valve operation or flow control.

Far more Valves of all types are "push-button" operated by Limitorque than all other makes.

Write on your business letterhead for catalog L-550, which fully illustrates and describes Limitorque.

LimiTorque®

PHILADELPHIA GEAR WORKS, INC.

ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.

Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

Limitorque Corporation • Philadelphia

THE NAME TO WATCH IN

HEAT TRANSFER EQUIPMENT

YUBA HEAT TRANSFER DIVISION

HEAT EXCHANGER DIVISION OF

formerly THE LUMMUS COMPANY

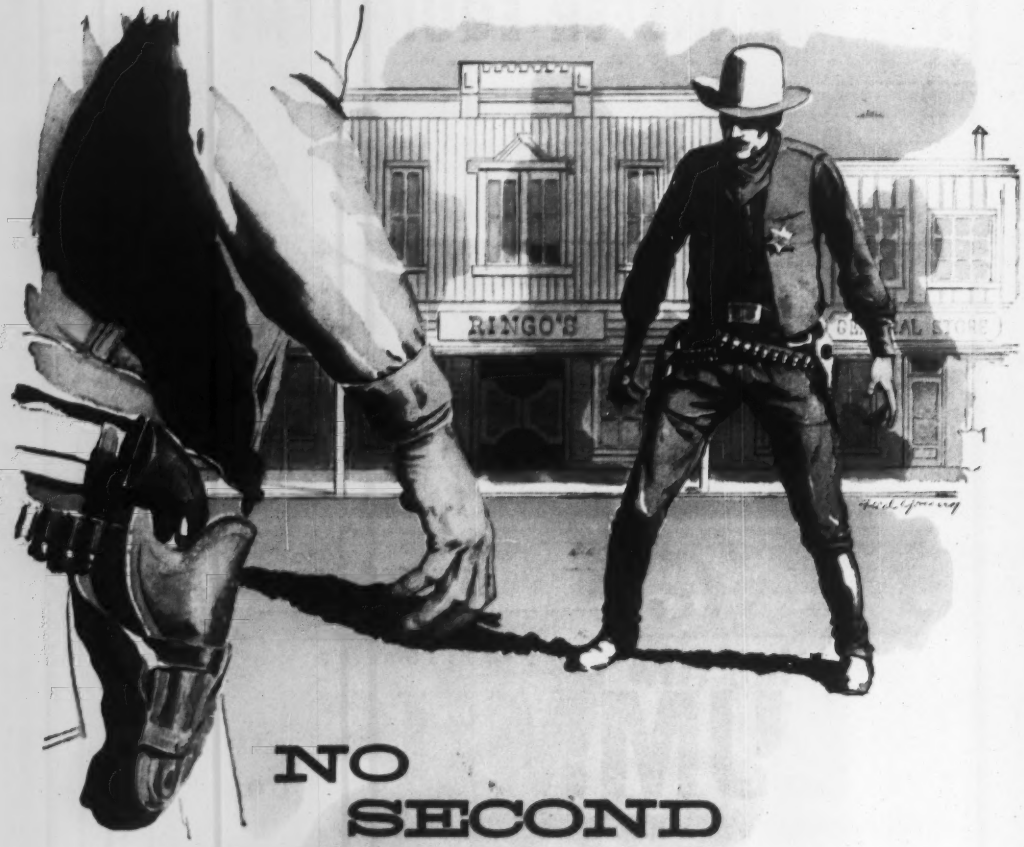
Important to every user of heat transfer equipment is the acquisition of the Heat Exchanger Division of The Lummus Company by Yuba Consolidated Industries, Inc. The management, sales and engineering personnel, as well as the designs, patents, and manufacturing facilities of the former Lummus operation at Honesdale, Pennsylvania, are now part of the YUBA nation-wide organization. YUBA is proud of the opportunity to identify its name with the long established recognition enjoyed by Lummus in the power industries, as well as in the chemical and petroleum processing fields. The continuing pioneering development for which Lummus has been known, and its existing commitments and obligations, will be carried forward in every phase under the YUBA name. For your current and future requirements consult YUBA first.

YUBA HEAT TRANSFER DIVISION

General Sales Offices and Plant — Honesdale, Pennsylvania
Eastern Division Sales Office — 385 Madison Ave., New York, N.Y.
Other Yuba Consolidated Industries, Inc. Plants: Buffalo, N.Y. • Richmond, Calif. • Benicia, Calif.

YUBA
CONSOLIDATED INDUSTRIES, INC.

NATION-WIDE SALES REPRESENTATION IN PRINCIPAL CITIES



NO SECOND BEST

When an aggressor threatens, you can't be **second best.**

That's the way it is in our business, too.

Our business is design and development of nuclear weapons—weapons that stop potential aggressors and defend our freedom.

And in this kind of work, either you're best, or you're nothing.

We can't afford to settle for less than the best—ever.

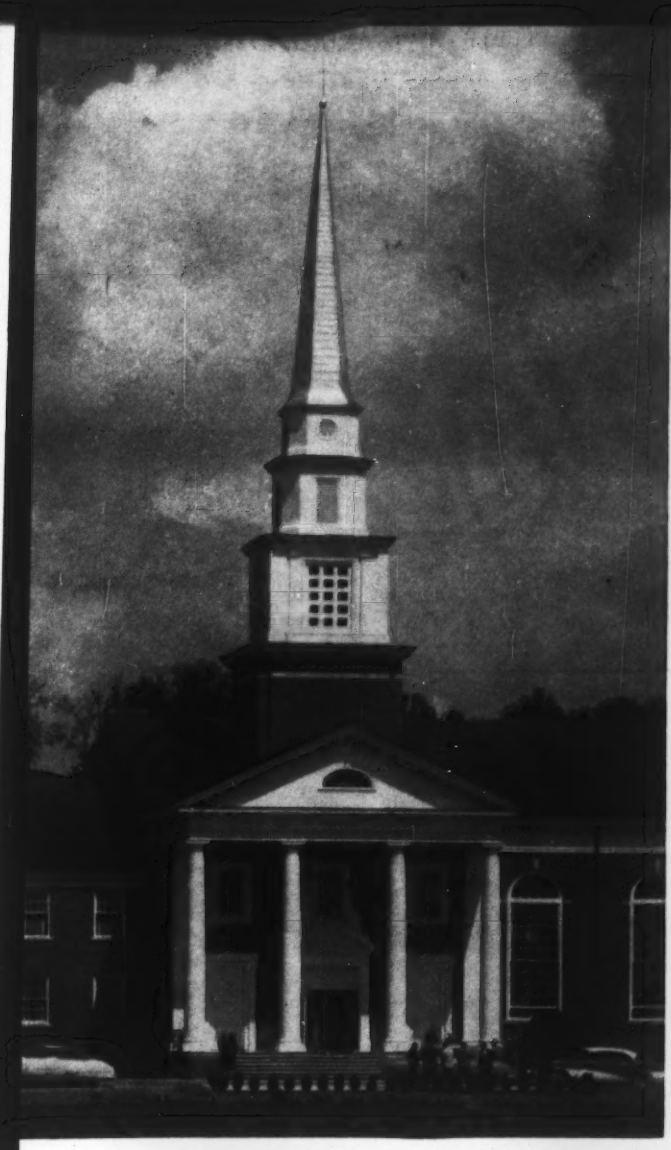
That applies to our engineers and scientists, too. As our job and its importance grows, we need more capable scientists. To those who qualify, we offer exciting opportunities for professional growth and individual advancement. Engineers, physicists, mathematicians, and other scientists are needed in a broad range of specialized fields.

We offer attractive living, too. In Albuquerque, a fine climate and a blending of ancient and modern cultures provide pressure-free, relaxed, pleasant living. The University of New Mexico, located here, provides opportunity to earn advanced degrees under a Sandia-sponsored educational aids program. Varied recreational activities are nearby and homes for rent or purchase are available.

MORE INFORMATION about Sandia Corporation, the work we do, and the opportunities now available are contained in our illustrated brochure. For your copy, please write Staff Employment Division 553.

SANDIA CORPORATION

ALBUQUERQUE. NEW MEXICO



NOTHING *can equal* *Stainless Steel*

in its unique combination of properties

No other design material can match Stainless Steel in its combination of desirable properties: corrosion resistance, strength, hardness, beauty, cleanability and easy fabrication. If you're looking for a reliable source of supply, remember that United States Steel offers you the widest range of types, finishes and sizes.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

SHEETS • STRIP • PLATES • BARS • BILLETS
PIPE • TUBES • WIRE • SPECIAL SECTIONS

USS

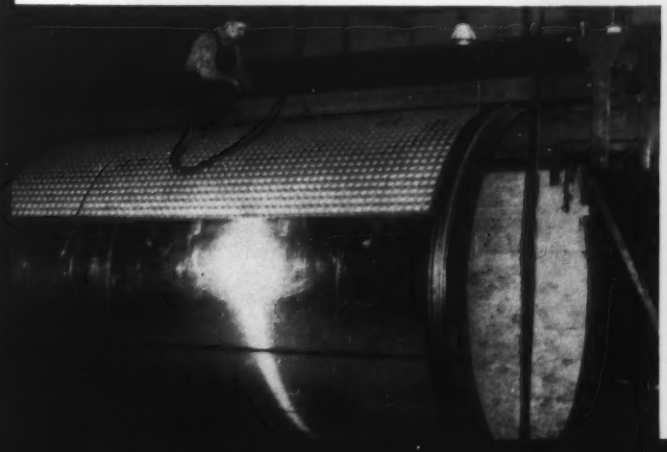
UNITED STATES STEEL

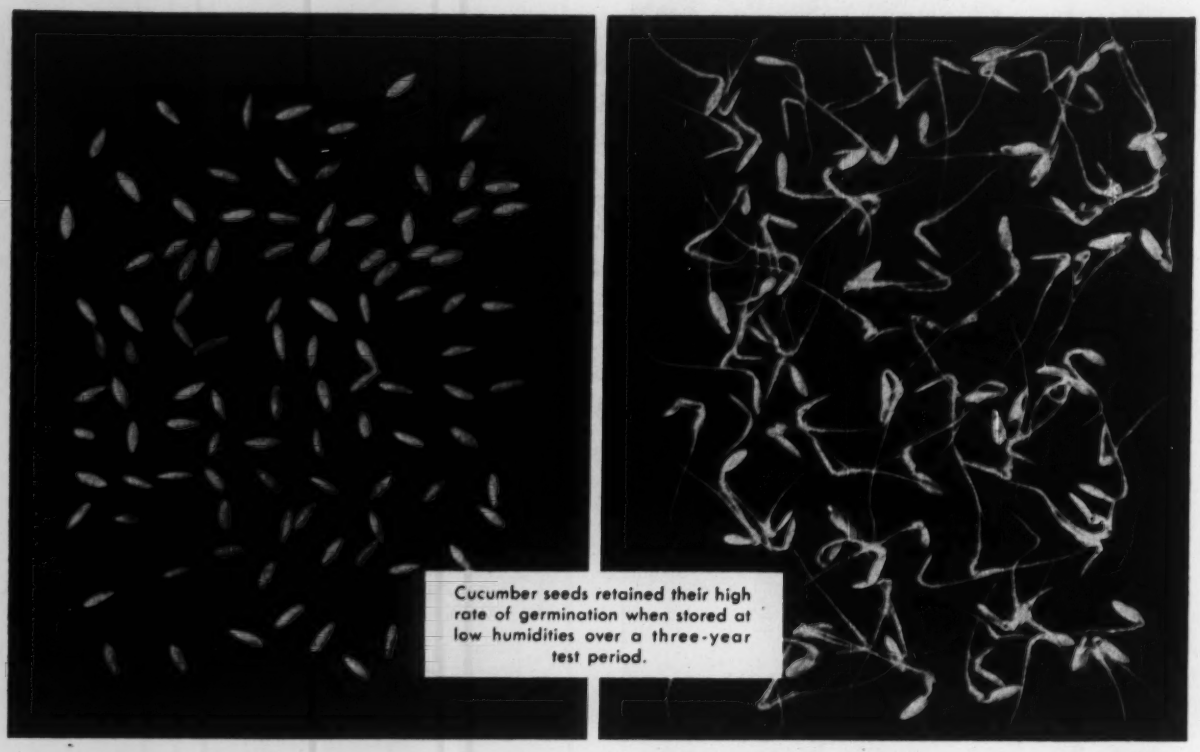
◀

FOR BEAUTY. Stainless Steel shingles in diminishing sizes create a beautiful, gleaming steeple for the State Street Methodist Church in Bristol, Virginia. Architect Allen Dryden, of Kingsport, Tenn., specifies Stainless Steel for jobs like this to assure lasting beauty, protection from weather and freedom from maintenance. This spire is sheathed in Type 302 26-gage Stainless Steel, and the cross is built of Type 302 Stainless bars. Construction details were engineered by Overly Manufacturing Company, Greensburg, Pa., who also fabricated and erected the steeple.

FOR FLEXIBILITY OF DESIGN. In this "Cold-Zone" cooling-storage milk products tank, made by Damrow Brothers Company, Fond du Lac, Wisc., Type 304 10-gage Stainless Steel was used for the smooth, easy-to-clean inner wall. Again Stainless Steel—this time Type 304 16-gage—was used for the dimpled outer wall which is stave-welded to the inner shell. This unusual design of dimple size and arrangement gives proper baffling and velocity to the refrigerant as it passes through the cooling area. Stainless Steel provides greater sanitation, durability, long life, strength and—the flexibility necessary to make this design possible.

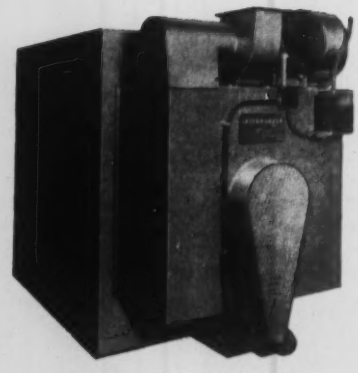
FOR DURABILITY. The Master Combination Padlock, designed for school locker room use and built by Master Lock Company, Milwaukee, Wisconsin, features a double-case construction—with Type 430 Stainless Steel used for the outer case. This Stainless Steel design makes it one of the strongest padlocks available. In addition to increasing the lock's durability, Stainless Steel also adds to its sales appeal and to its resistance to the corrosive atmospheres of damp locker rooms. The springs, too, are made from USS Stainless Steel—Type 304 Ameroxide coated wire.





Cucumber seeds retained their high rate of germination when stored at low humidities over a three-year test period.

Seeds stored in DRY rooms stay vigorously alive



CH Lectrodryers keep storage areas DRY.

VEGETABLE SEEDS pick up moisture rapidly if stored in a humid atmosphere. And the higher their moisture content, the more rapidly seeds lose their capacity to germinate and grow into healthy plants.

As long ago as 1937, The Kilgore Seed Company of Plant City, Florida, recognized the need for maintaining DRYness in seed storage rooms. Today a Type CHK Lectrodryer* is used to obtain and maintain any selected per cent of relative humidity which is desired in the seed storage room.

Refrigeration as a means of lowering humidity is not satisfactory here, since seeds sweat when brought out of storage. Thus DRYing with Lectrodryers provides added protection, avoiding sweating.

Because Moisture Isn't Pink shows how others are safeguarding materials and processes with Lectrodryers. For a copy, write Pittsburgh Lectrodryer Division, McGraw-Edison Company, 335 32nd Street, Pittsburgh 30, Pa.

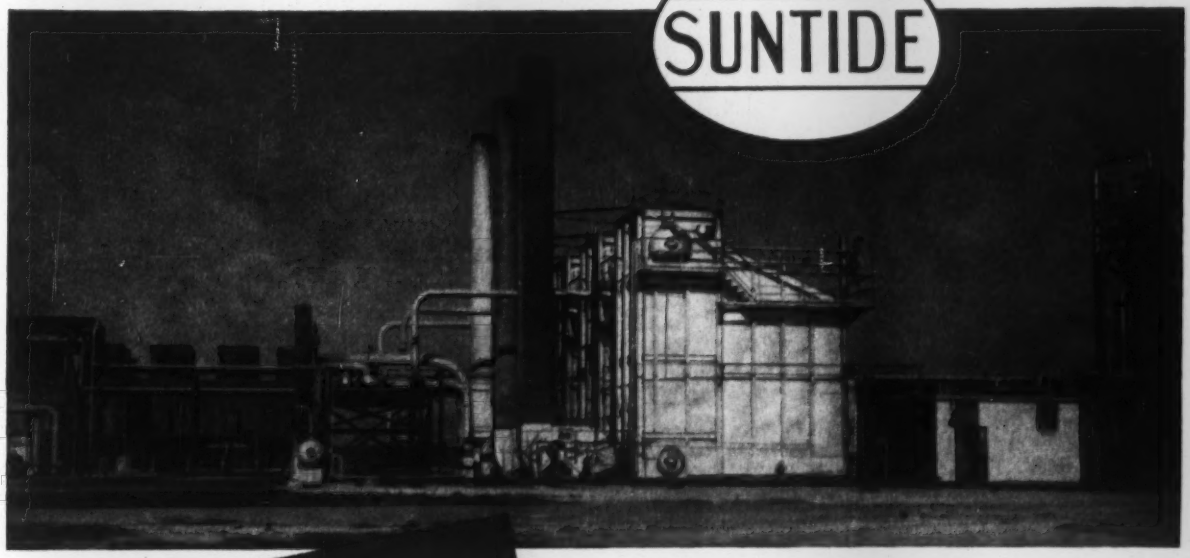
Lectrodryer

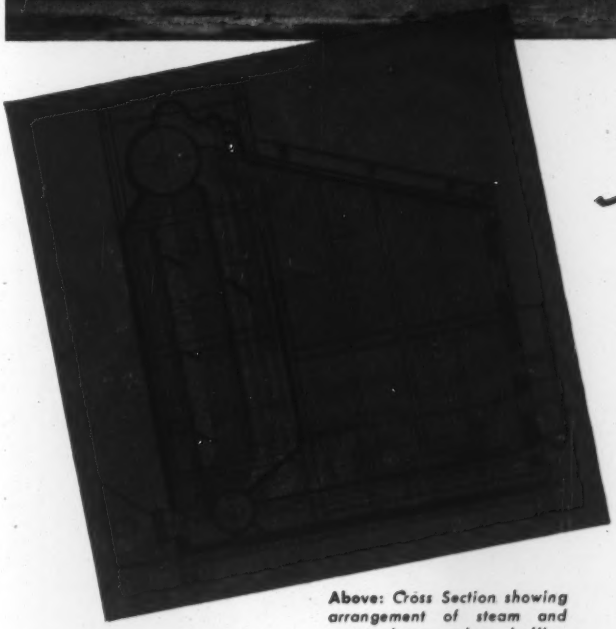
*REGISTERED TRADEMARK U. S. PAT. OFF.

STEAM GENERATORS

at SUNTIDE REFINING COMPANY

Viola, Texas





Above: *Cross Section showing arrangement of steam and water drums, tubes, baffles, and furnace.*

3 Units Installed
2 Units on Order

Principle Data Each Unit

- 85,000 pounds steam per hour capacity, designed for 500 lbs. S.W.P. and 625° F. total temperature.
- Water cooled furnace.
- Burners for Gas and Oil fuel.

Vogt offers a complete line of custom built and package type steam generators. Available in bent tube and straight tube designs for solid, liquid, or gaseous fuels burned singly or in combination.

Write for bulletins. Dept. 24A-BM

OTHER VOGT PRODUCTS

Drop Forged Steel Valves, Fittings and Flanges—
Petroleum Refinery and Chemical Plant Equipment
Heat Exchangers
Ice Making and Refrigerating Equipment

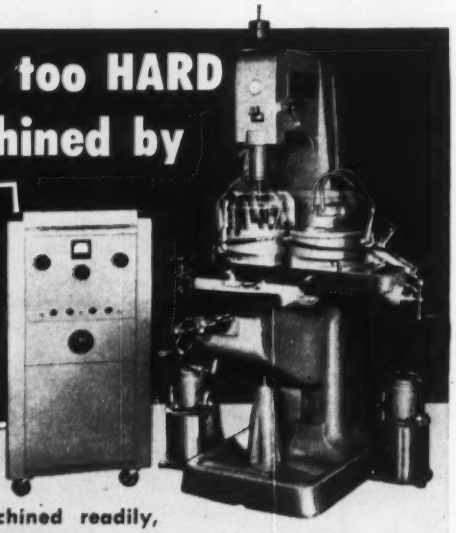
HENRY VOGT MACHINE CO.

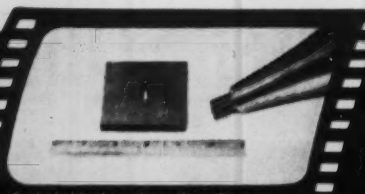
Box 1918, Louisville 1, Kentucky

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati

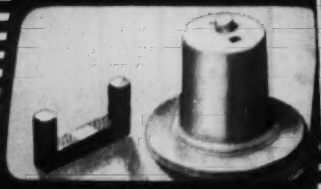
Nothing is too HARD to be Machined by

Sheffield's CAVITRON

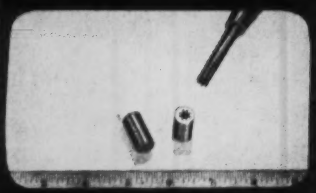




Carbide blanking die and the Cavitron tool used to sink it

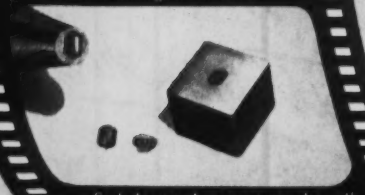


Ferrite yoke slotted after sintering and glazed porcelain in which three round and one square cavities were sunk



H.S.S. lockwasher die blank, die and the tool which produced it

H.S.S. blanking die and tool



Carbide signet ring coining die with finished ring and Cavitron tool

Cavitron is an ultrasonic tool by which even the hardest materials are machined readily, accurately and economically. And without regard for their electrical characteristics.

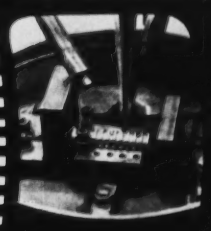
Because no heat is generated by the machining process no change is produced in physical properties of the material machined.

Cavitron is designed and built by the Sheffield Corporation which has been manufacturing precision tools for 50 years. In Cavitron you get the accuracy, rigidity and ease of control characteristic of the highest American Standards.

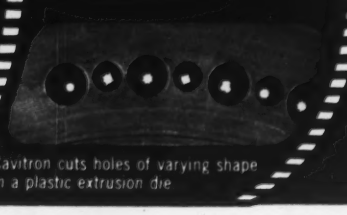
MACHINABLE MATERIALS	MACHINING OPERATIONS	PRODUCTS PRODUCED
Hardened tool steel	Drilling—boring	Dies, steel and carbide
Cemented carbides	Contouring—Engraving	Machine and motor elements
Ferrite—Germanium	Slicing and dicing	Electrical and electronic components
Cermets—ceramics—glass	Tapping	Jewell bearings—tools
Aluminum oxide		Tire molds—carbide inserts
Precious stones—quartz		

Group of parts machined by Cavitron

Group of Cavitron machines in assembly.



Sinking diamond shaped ports in a servo valve sleeve.



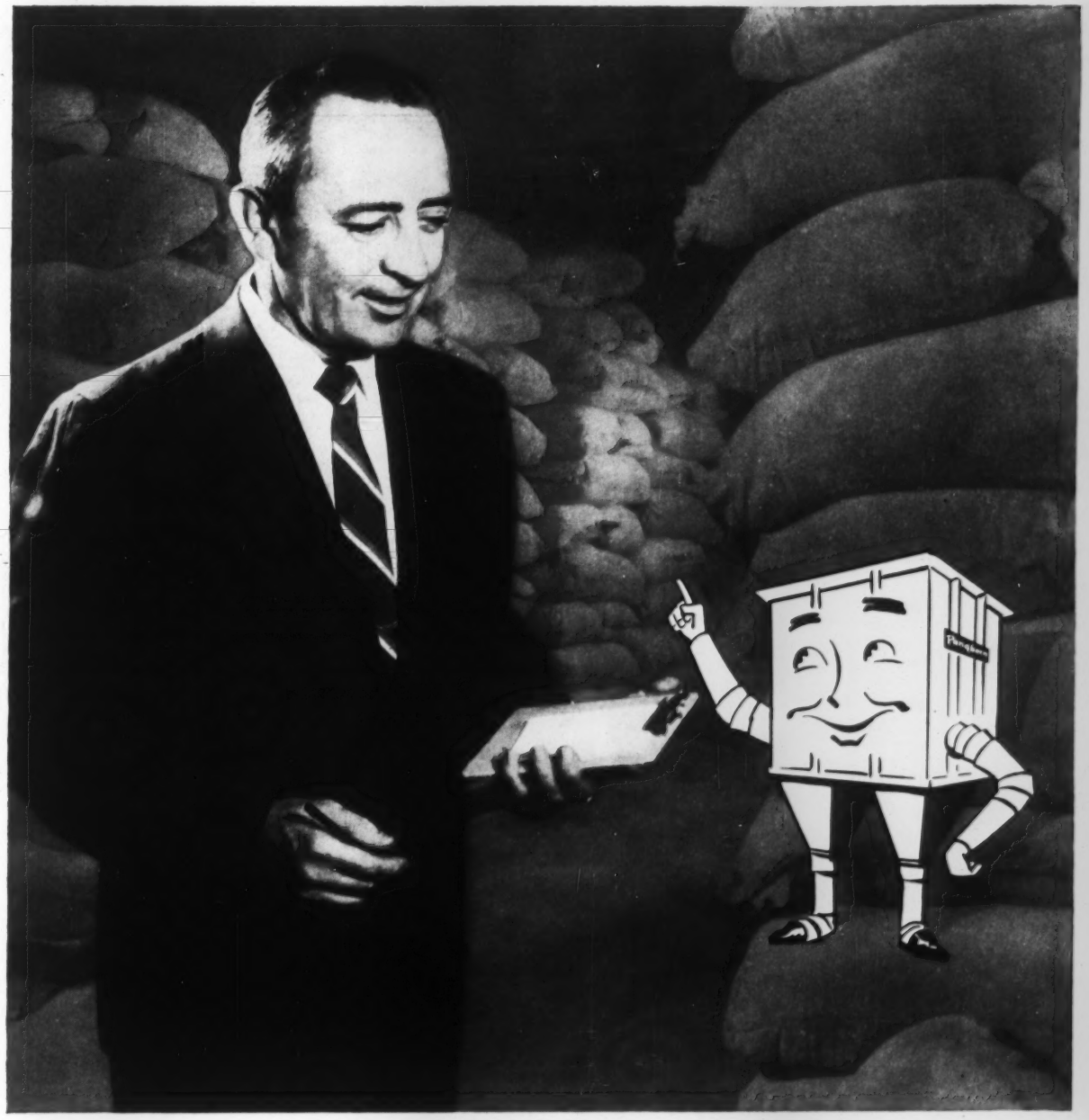
Cavitron cuts holes of varying shape in a plastic extrusion die

Have a Sheffield engineer show you in your own office the recent sound-slide film "Machining the Unmachinable." Here is Cavitron in operation. Write to Div. 41—*THE SHEFFIELD CORPORATION, Dayton 1, Ohio, U.S.A.*

7906

the **SHEFFIELD** *corporation*

...surement for mankind



"You mean $15,000 a year salvaging dust?"

That's just what we mean! Many of our customers are clearing $15,000 a year and more from valuable material reclaimed by Pangborn Dust Control. Efficient Pangborn Dust Collectors trap dust at the source, gather it ready for resale, re-use or disposal. As a matter of fact, users of Pangborn Dust Control have made $20,000, $36,000, even $75,000 a year in salvaged dust, depending on the value of the dust collected.

What's more, Pangborn gives you other benefits of lower housekeeping costs, longer machinery life, higher employee efficiency and better employee and community relations. And Pangborn offers a complete line of collectors for all jobs.

Why not discover how you can profit from Pangborn Dust Control? Write for Bulletin 922 to PANGBORN CORP., 2200 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Dust Control & Blast Cleaning Equipment.*

Pangborn CONTROLS DUST

For piping systems that can't be anchored, use ZALLEA HINGED EXPANSION JOINTS

Piping systems like the one in this 63,750 bbl/day catalytic cracking unit, one of the world's largest, at Gulf Oil Corp. Girard Point Refinery, have to be entirely self supporting. The entire cracking unit . . . reactor, regenerator and all connecting lines . . . is suspended in a huge structural steel framework, counterweighted to keep the system in balance, and fitted with Zallea Hinged Expansion Joints to provide vital flexibility plus support for the reactor.

In the 150 ft. air supply line, all thermal movement of the piping is absorbed by angular displacement in three 42″ dia. Zallea Hinged Expansion Joints. Start-up air in this line is at 1000°F. Under operating conditions it is delivered at 250°F, 25 psig.

Two 50″ dia. Zallea Hinged Expansion Joints in the spent catalyst line carry fluidized cracking catalyst at 950°F, 13 psig.

Since this cracking unit first went on stream, these Zallea Expansion Joints have given completely trouble-free service.

Process piping of any kind can be fully protected with one or more Zallea Expansion Joints. From the complete Zallea line you can select the expansion joint or combination of expansion joints best suited to your particular problems.

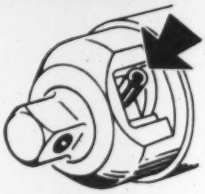
Get the complete story in our new 72-page manual. Write today, on your company letterhead, for your copy of Catalog 56. Zallea Brothers, 8[illegible] Locust Street, Wilmington 99, Delaware.

Zallea expansion joints

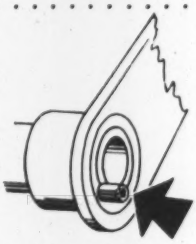
Zallea Brothers • Wilmington 99, Delaware

World's largest manufacturers of expansion joints

Rollpin replaces 12 different fasteners



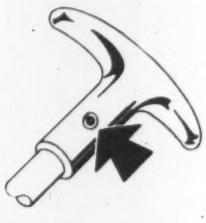
REPLACING A GROOVED PIN . . . in this application, Rollpin serves as a step pin in a ratchet wrench adaptor. With its light weight and high shear strength, Rollpin functions perfectly . . . cuts assembly costs.



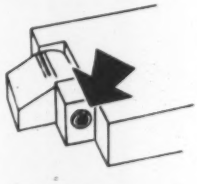
REPLACING A KEY . . . Rollpin demonstrates its ability to do away with precision tolerances, in this heating system damper arm. Faster, cheaper and more satisfactory than previous assemblies.

REPLACING A RIVET SHAFT . . . Rollpin serves as an axle for the sparkwheel of a cigarette lighter. No riveting or threading necessary . . . faster assembly. Note flush, clean fit.

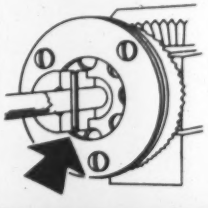
REPLACING A COTTER PIN . . . Rollpin assembly time is shorter, service life ten times longer. Vibration-proof flush fit. Easily removable.



REPLACING A SET SCREW . . . to fasten automobile brake handle a short length Rollpin is self-retained in the hand grip but can easily be driven into over-drilled hole in shaft for simple handle removal.

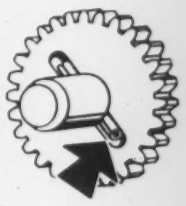


REPLACING A CLEVIS PIN . . . here Rollpin holds firmly in clevis, permits free action of moving member. Rollpin application shown is the plate of a home workshop tool.

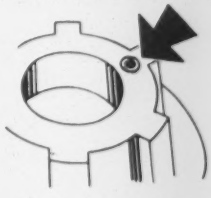


REPLACING TAPER PINS . . . in the assembly of precision differentials eliminated cost of taper pin reamers and the entire reaming operation. Rollpin costs less than a taper pin and installation is cheaper. They remove easily.

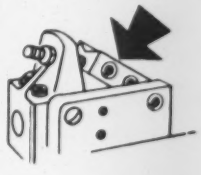
REPLACING A HEADED PIN . . . in this hinge pin application, Rollpin is simply and inexpensively driven in place, greatly reducing assembly costs. Constant spring tension holds Rollpin firmly in place . . . eliminates loosening of hinge due to wear.



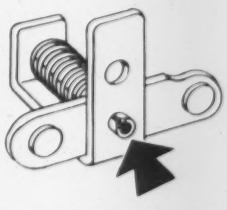
REPLACING A HUB ON A GEAR . . . Rollpin, self-retained in shaft, is simply snapped into molded slot to position sintered gear. This application, by an office equipment manufacturer, effects major savings in assembly. Rollpin's high shear strength is particularly valuable here.



REPLACING A DOWEL PIN . . . Rollpin is used here to prevent rotation of a thrust bearing. No reaming, no special locking. Easily removed. Lowest possible dowel pin cost.

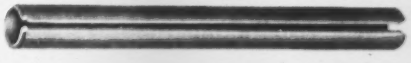


REPLACING A BOLT AND NUT . . . Rollpins act as fasteners and pivots for the linkages in this electric welder. Rollpins may be used with a free fit in outer or inner members depending upon product design requirements.



REPLACING A RIVET . . . Rollpin serves as guide shaft for spring-loaded electrical interlock contacts. This electrical equipment manufacturer reports that rivet failure previously occurred at the clinched end under normal operating impact and vibration.

WHERE CAN YOU USE THIS SIMPLE FASTENER?



Rollpin is the slotted tubular steel pin with chamfered ends that is cutting production and maintenance costs in every class of industry.

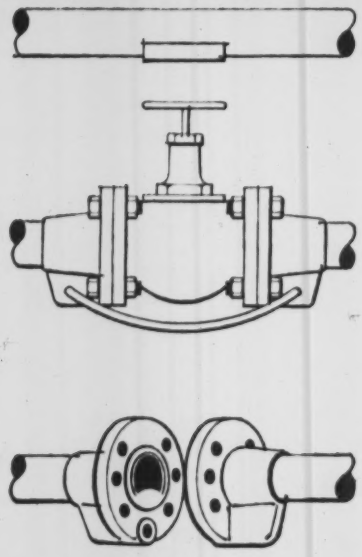
Drives easily into standard holes, compressing as driven. Spring action locks it in place—regardless of impact loading, stress reversals or severe vibration. Rollpin is readily removable and can be re-used in the same hole. Made in carbon steel, stainless steel and beryllium copper. Write for samples and information, ELASTIC STOP NUT CORPORATION OF AMERICA, 2330 Vauxhall Road, Dept. R47-811, Union, New Jersey.

ROLLPIN TRADEMARK

ELASTIC STOP NUT CORPORATION OF AMERICA

2330 VAUXHALL ROAD, UNION, NEW JERSEY

With this new round shape, UNITRACE costs substantially less per foot. And since the steam passage has less outside wall area, external radiation heat loss is reduced. The need for thermal insulation is often eliminated. When insulation is used, it costs less because standard pre-formed pipe covering can be used.
to cut costs,
boost efficiency
of steam traced pipe...
ALCOA UNITRACE has a NEW SHAPE
for lower cost per foot...
easier joining...
less heat loss...better
internal heat transfer



Sections of UNITRACE in the new shape can be easily and quickly joined by the weld and patch method (top). And a brand new UNITRACE flange—with product and steam passages cast as integral parts of the flange—simplifies installation of valves (center) and other flanged connections (bottom).

Want to save money on steam-traced piping? Here's good news for your pocketbook! ALCOA® UNITRACE *has a new cost-cutting shape* . . . a round section matching standard pipe shapes . . . available in 1½", 2", 3" and 4" sizes.

With steam and product passages extruded in a single unit of light, strong, corrosion-resistant Alcoa aluminum alloy 3003-F, UNITRACE completely eliminates the cost of external steam jackets or tracer tubes. And the new UNITRACE shape makes possible these *extra* savings:

Lower cost per foot . . . total volume of metal is less; material costs are lower.

Easier, faster joining . . . new configuration (with exterior grooves for quick steam passage identification) makes mating and joining fast and simple to cut installation costs.

Less external heat loss . . . improved internal heat transfer . . . the new design reduces area for external radiation loss.

The natural corrosion resistance of aluminum makes UNITRACE ideal for handling naval stores, molten sulfur, ammonium nitrate solutions, glacial acetic acid, fatty acids, tar, pitch, wax, urea and similar products which normally require heated transfer lines.

Find out today how *you* can use ALCOA UNITRACE to cut costs and improve efficiency of your heated transfer lines. Call your nearest Alcoa sales office, or write Aluminum Company of America, 908-J Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

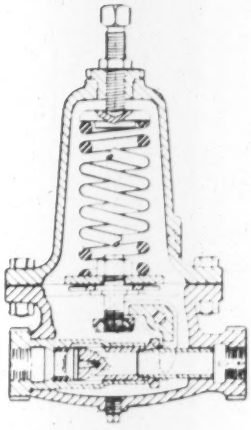
THE ALCOA HOUR
TELEVISION'S FINEST LIVE DRAMA
ALTERNATE SUNDAY EVENINGS

Write for this FREE BOOKLET!
This new, illustrated booklet contains complete engineering, specification and fabrication data on ALCOA UNITRACE in the new shape. It's your guide to low cost heated transfer lines. Write for it today!

For better molded products...

CASH STANDARD type 1000 VALVES

keep mold temperatures in the "Safety Zone"



In the production of molded parts, uniform quality is assured through careful control of time, temperature, pressure and other factors in the molding cycle.

A leading producer of precision molded plastics parts is General Electric Company's Plastics Department, Decatur, Ill. On G-E's compression molding machines, almost 200 Cash Standard Type 1000 Reducing Valves are in use, keeping mold temperatures constant by controlling the steam supply.

Donald F. Thompson, G-E's Supervisor of Plant and Facilities Engineering, says: "For our particular application, where we use a large number of reducers, it is essential that the initial cost and maintenance cost be held to a minimum. We have found that Cash Standard 1000's have done the job very effectively."

The unique construction of this valve provides high capacity and accurate control of steam, water, air, oil and most gases and chemicals. Exclusive streamlined inner valve eliminates turbulence; flow through valve housing is in a straight uninterrupted line; an aspirating effect controls valve opening by amplifying slight pressure changes into large valve operating forces.

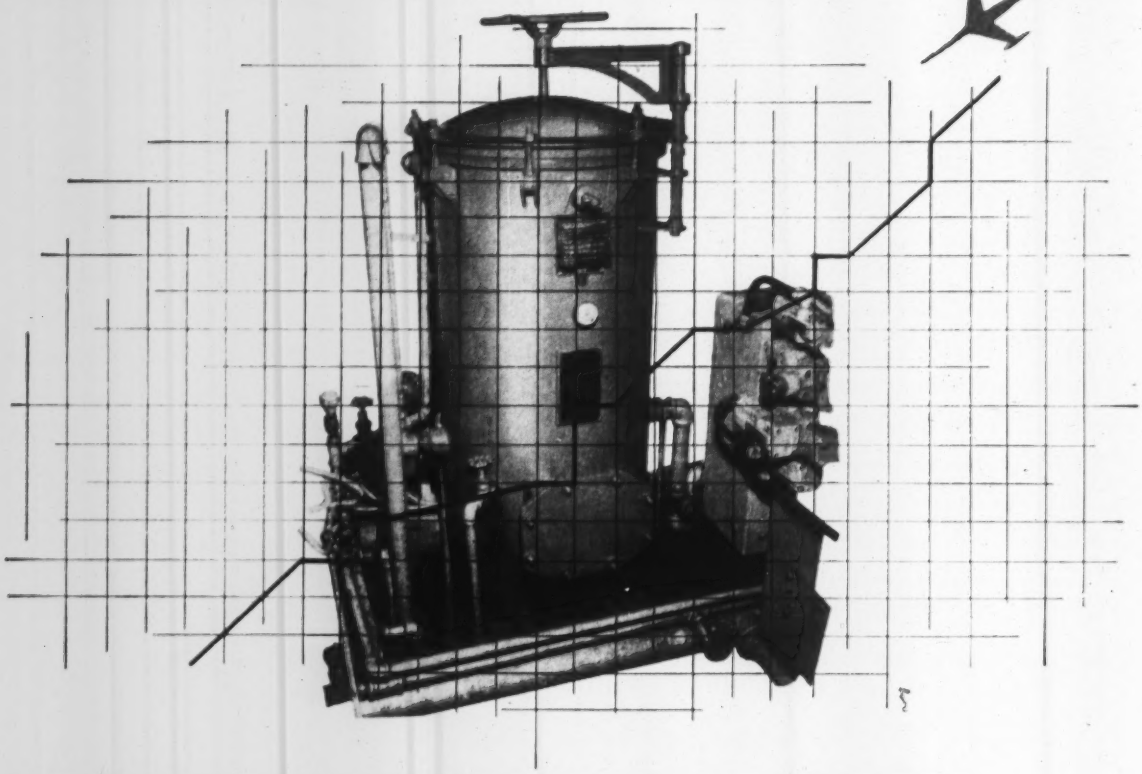
What's *your* control problem? Contact the Cash Standard control specialist in your area for more information on this unusual valve and other Cash Standard control products, or write Dept. C.

CASH CS **STANDARD**

A. W. Cash Co. and Its Subsidiary, Cash Standard Stacon Corp.
P. O. Box 551, Decatur, Ill.

Pressure, Hydraulic, Temperature, Process and Combustion Controls

Hoffman engineered systems get **results:**



HOFFMAN COOLANT FILTRATION SYSTEM

achieves great savings on honing operations at **BENDIX AVIATION!**

Engineers at Bendix Aviation Corporation, Pacific Division, found that oil used in the honing of aircraft hydraulic cylindrical barrels quickly became saturated with small particles. Efficiency was being pushed down by scratches in the bores of the barrels, by the need for continual trueing of honing stones and by production loss and re-working. At the same time, costs were being pushed up by the replacement of honing stones and oil solution—100 gallons a month—as well as by re-work expense.

Hoffman engineers recommended a central pressure filter system to treat the coolant from seven hones, with a combined flow rate of 25 g.p.m. The tiny particles are continuously filtered out by an inexpensive filter medium which is easy to replace. As a result, Bendix Aviation is making substantial savings on honing oil and stones . . . production has been increased . . . and far fewer pieces have to be re-worked.

On the basis of 250 working days per year, the installation had paid for itself within 16 months!

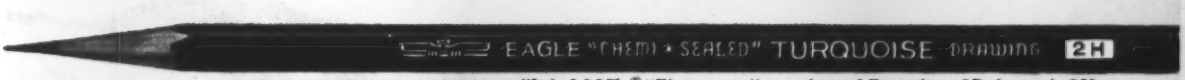
Hoffman "custom" filtration equipment has added efficiency and cut expenses in many types of industry. Wouldn't it be well worth your while to look into the impressive savings a Hoffman filtration system could bring **you?** Write for Case Study No. 7, Bulletin M-129.

INDUSTRIAL FILTRATION DIVISION U. S. HOFFMAN MACHINERY CORPORATION DEPT. ME, 103 FOURTH AVENUE, NEW YORK 3, N.Y.

INDUSTRIAL FILTRATION DIVISION Machine Tool Coolant Clarifiers—Flotation, Mechanical, and Magnetic. Lubricating and Insulating Oil Conditioners, Filters, and Vaporizers. Solvent Recovery Systems—Vacuum Stills and Filters. **ORDNANCE EQUIPMENT DIVISION** Special Pneumatic Conveying Systems. High Efficiency Centrifugal Separators. Stationary and Portable Vacuum Cleaning Equipment. Process Equipment. Pneumatic Systems for Radioactive Materials. **AIR APPLIANCE DIVISION** Multistage Centrifugal Blowers and Exhausters. Pneumatic Conveying Equipment. Industrial Vacuum Cleaning—Portable and Stationary Systems. Continuous Metal Strip Driers. "Smoothflow" Fittings and Tubing.

do your **drawings** do justice to your **designs?**

It takes a sharp drawing to sell a sharp idea—and you're halfway there when you pick up an **EAGLE** TURQUOISE drawing pencil. *No pencil on the market can match TURQUOISE for reproduction!* For one thing, TURQUOISE is tops for uniform grading. 17 scientific formulas guarantee exactly the blackness you want—from every pencil, every time! You get a strong needle point that just won't crumble—and stays sharp for line after long line of unchanging width. You can't beat it for smoothness, either—thanks to Eagle's exclusive ®"Electronic" graphite. TURQUOISE makes your drawings look sharp—and *you, too!*



• **TURQUOISE DRAWING PENCILS:** With 100% ®"Electronic" graphite. 17 grades, 6B through 9H.

• **TURQUOISE CLEANTEX ERASER:** Super-soft, non-abrasive rubber.

• **TURQUOISE DRAWING LEADS:** Fit any standard holder. Grades 5B through 9H.

• **TURQUOISE LEAD HOLDERS:** Hold any grade of Turquoise lead—so firmly that lead cannot be pressed back.

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a new development in atomic power HIGH TEMPERATURE TEST FACILITY

At Bettis Atomic Power Division, engineers are designing and developing a zero-power pressurized water test reactor known as the High Temperature Test Facility. How to measure the precise relationship between temperature and reactivity in pressurized water moderated reactors has been a problem facing scientists and engineers. This new facility will improve the theoretical understanding of the physics behavior of such a reactor with changes in temperature.

One of the key engineering problems in the design of this facility is the need for rigorous temperature control in the moderator system which will supply a precise temperature environment to the zero-power core.

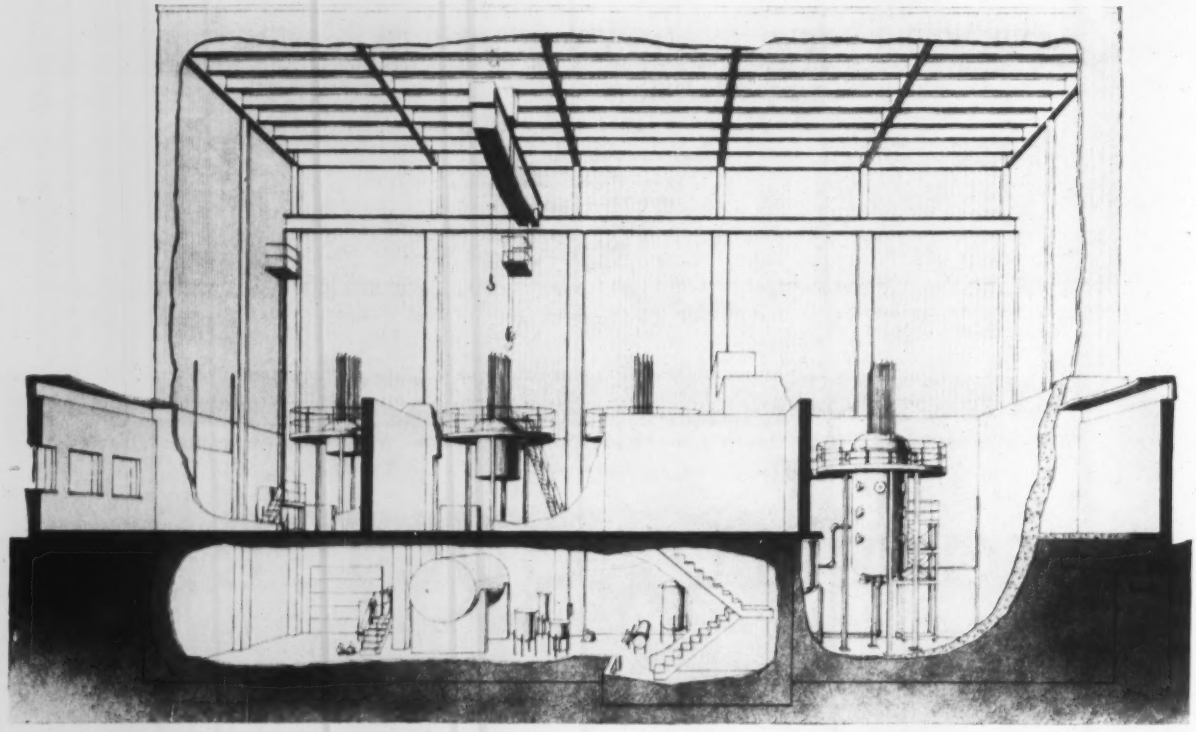
Engineers must also design into the reactor vessel enough flexibility to allow it to hold experimental reactor cores of varying sizes. The vessel itself should have sufficient wall penetrations to allow accessibility to the core for special instrumentation.

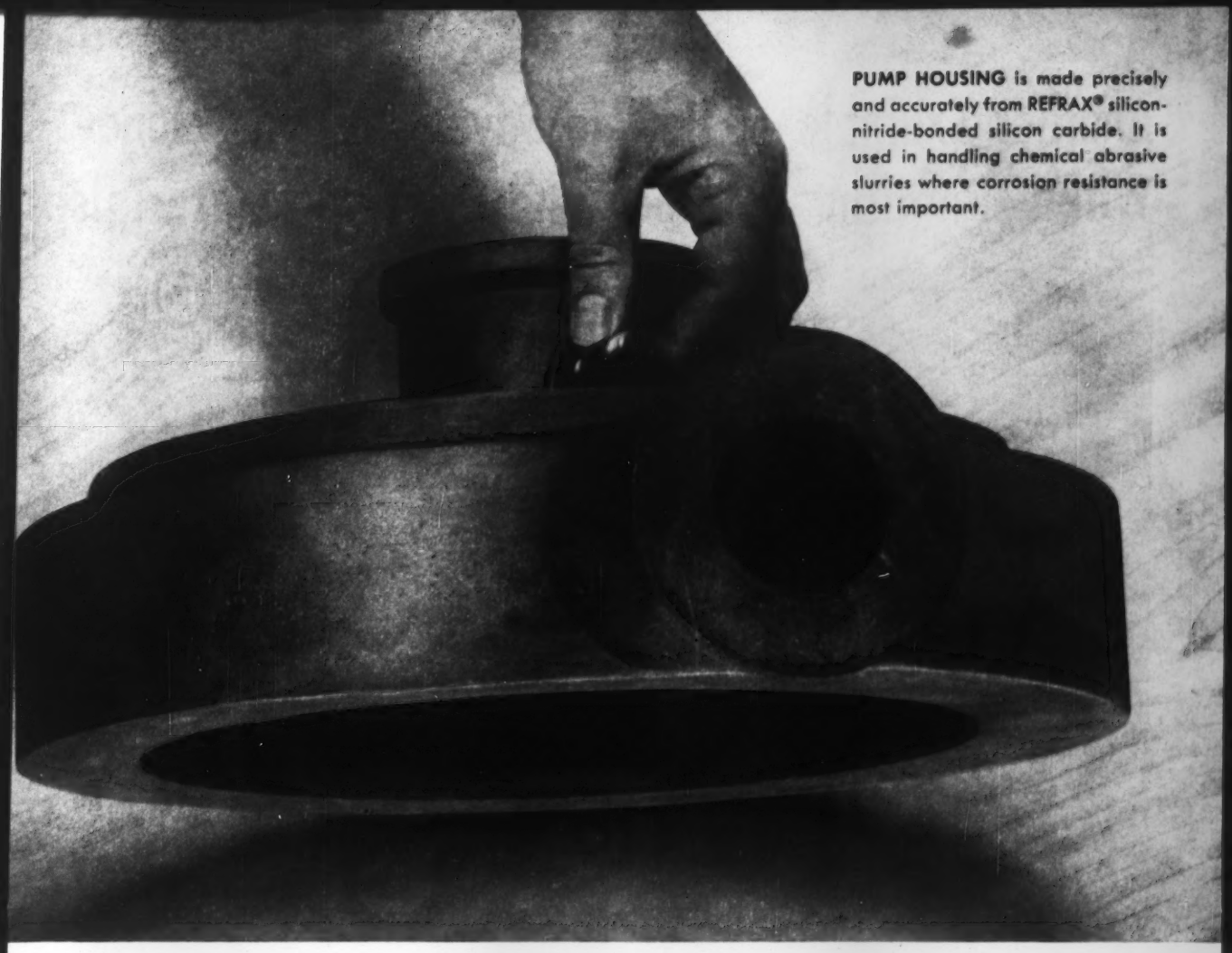
This facility will be constructed to meet the rigorous standards for reliability and safety established for the nuclear industry.

This is only one example of the challenging work conducted here. We welcome inquiries from engineers interested in the excellent careers offered by the new and growing nuclear power industry. Please send your résumé to: Mr. M. J. Downey, Bettis Atomic Power Division, Westinghouse Electric Corp., Box 1468, Dept. A-199, Pittsburgh 30, Pa.

BETTIS ATOMIC POWER DIVISION

Westinghouse





PUMP HOUSING is made precisely and accurately from **REFRAX®** silicon-nitride-bonded silicon carbide. It is used in handling chemical abrasive slurries where corrosion resistance is most important.

Refractories... to surpass **metals**

What material combines *all* the following properties? Corrosion resistance so that it is not wet by molten aluminum, and resists attack by most acids; abrasion resistance that prevents wear by both high velocity particles and sliding heavy masses; the ability to withstand temperatures to 3000° F; hot strength so high that at 2450° F its modulus of rupture is 5600 psi?

What material *combines* all these properties? Obviously not a metal, not even a cermet. It is one of Carborundum's special refractories — REFRAX® silicon-nitride-bonded silicon carbide. This material can be precisely formed to tolerances of ±0.005 in./in. with external and internal threads. Finish resembles that of a cast iron part.

Your high temperature problem, no matter how complex it may be, can almost certainly be solved with one of the scores of super refractories by Carborundum. For assistance, write for these three booklets:

CARBORUNDUM
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MAIL THIS COUPON TODAY

Refractories Division,
The Carborundum Company, Perth Amboy, N. J., Dept. 197

Please send me:

- ☐ Current issue of Refractories magazine on REFRAX®
- ☐ Reprint of article in Product Engineering, Feb. '57 entitled "Nitride-bonded silicon carbide bridges gap between metals and ceramics".
- ☐ Bulletin on REFRAX®

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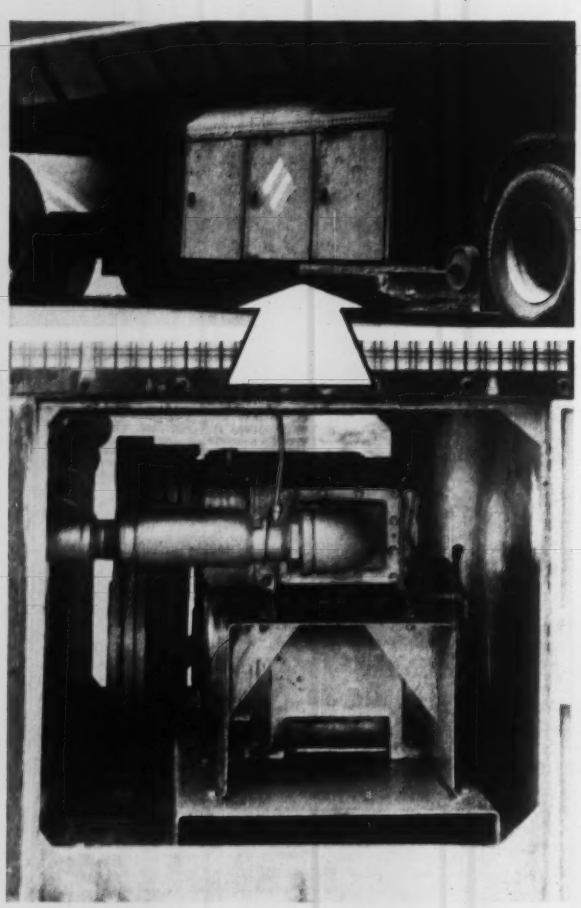
Company _____

Street _____

City _____ Zone _____ State _____

Another Example of How to Save Time and Money When Handling Powdery and Granular Materials



COMPACT UNDER-TRAILER TWO-STAGE BLOWER UNIT UNLOADS FLOUR TRUCK IN 1¼ HOURS

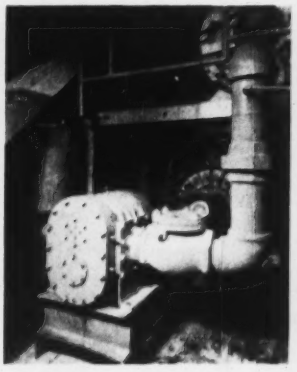
The compactness of pneumatic conveying installations using M-D Blowers is illustrated by this under-trailer two-stage unit, which includes a rotary air valve and a 30 hp. motor. The combined weight of the two M-D Blowers is only 325 lbs. compared with the 1300 lbs. of the two blowers used in a previous truck installation. Capable of operating at pressures up to 12 psig, the first-stage blower handles 225 cfm at 7 psig with an operating speed of 2100 rpm. The second-stage blower discharges at 18 psig. The trailer can be unloaded in about 1¼ hours.

Eckhart Milling Company Incorporates Pneumatic Conveying Into Existing System, Using Miehle-Dexter High-Pressure, Small-Cube Blowers

Converting manual and mechanical methods of handling powdery and granular materials to a pneumatic system need not involve major revisions in plant layout.

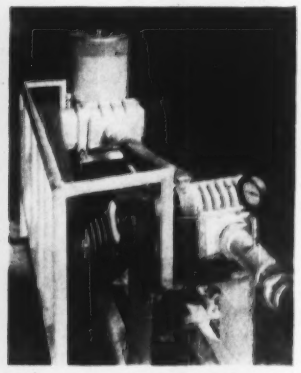
Good examples are the time- and money-saving pneumatic handling installations at Eckhart Milling Co., Chicago. Designed and installed by Eckhart at the instigation of J. N. Chisam, Vice President of Production, the conversion employs five high-pressure, small-cube, lightweight Miehle-Dexter 3-Lobe Rotary Positive Blowers. The exclusive design features of the M-D Blowers enabled Mr. Chisam to plan the installation in a minimum of space without majorly disrupting the existing plant layout.

A variety of materials can be conveyed by M-D Blowers. The complete Eckhart story may suggest a money-saving pneumatic conveying installation in your plant. May we send it to you?



LOADING TIME REDUCED 58%

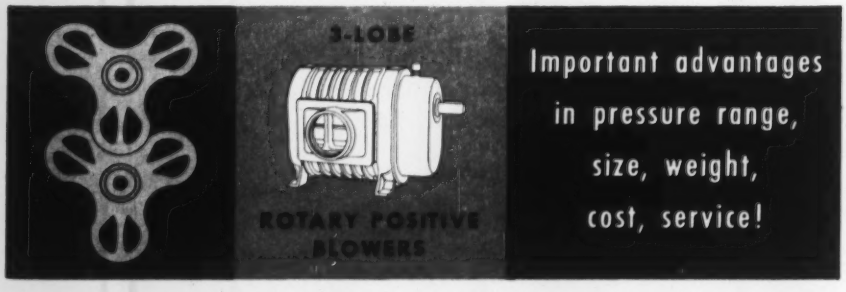
The flour truck is now loaded pneumatically in 50 minutes. Formerly 2 hours were required with a screw conveyor. The single-stage M-D Blower, operating at 1900 rpm, delivers 320 cfm at 9 psig.



BRAN BIN EMPTIED IN 30 MIN.

Bran is pneumatically loaded into freight cars by this two-stage M-D Blower unit similar to the truck installation. Bins are now emptied in 30 minutes. Formerly 2 men were required on each of 3 shifts.

miehle dexter

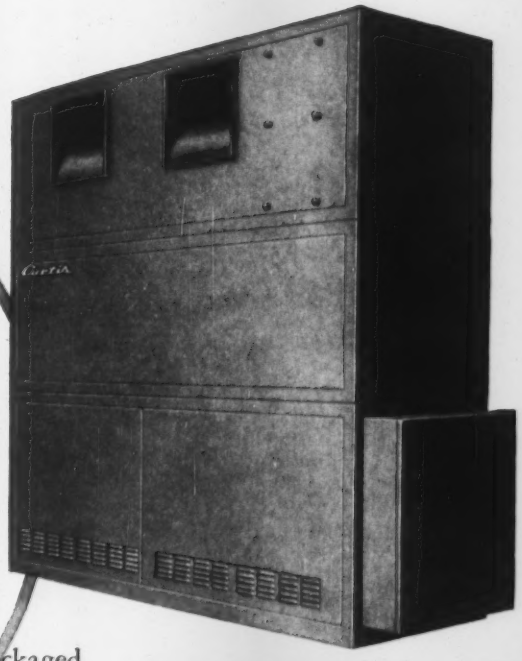


MIEHLE-DEXTER DIVISION, RACINE, WIS. • TELEPHONE MELROSE 4-5521 • Another Product of MIEHLE-GOSS-DEXTER, Incorporated

NOW!

Curtis

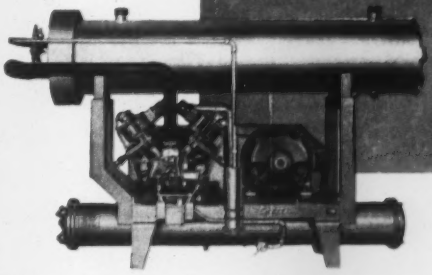
PACKAGED UNITS
Up to 50 Tons
OPENS NEW MARKETS FOR PACKAGED AIR CONDITIONING



No question about it. The new 50-ton Curtis packaged air conditioner will open a new sales front for you. Architects, engineers *and* owners prefer packaged units for important reasons:

- Big package units are line assembled—does away with expense of field labor. Assures a BALANCED SYSTEM.
- Packaged units are easier to install—take up less space.
- Cuts down installation problems and maintenance costs.

IMPROVED PACKAGED LIQUID CHILLER... FOR WET HEAT SYSTEMS



up to 100 tons—

With all controls in single panel box for easier access and greater protection! Four step capacity control—unloaded starting available. Particularly desirable where year 'round conditioning of multiple individual rooms is required.

REMEMBER, every Curtis unit is backed by a solid 103 years of experience and skill. Curtis offers a complete line of air conditioning equipment—nationally advertised to help you sell.

YOU CAN COUNT ON

REMEMBER... **Curtis**

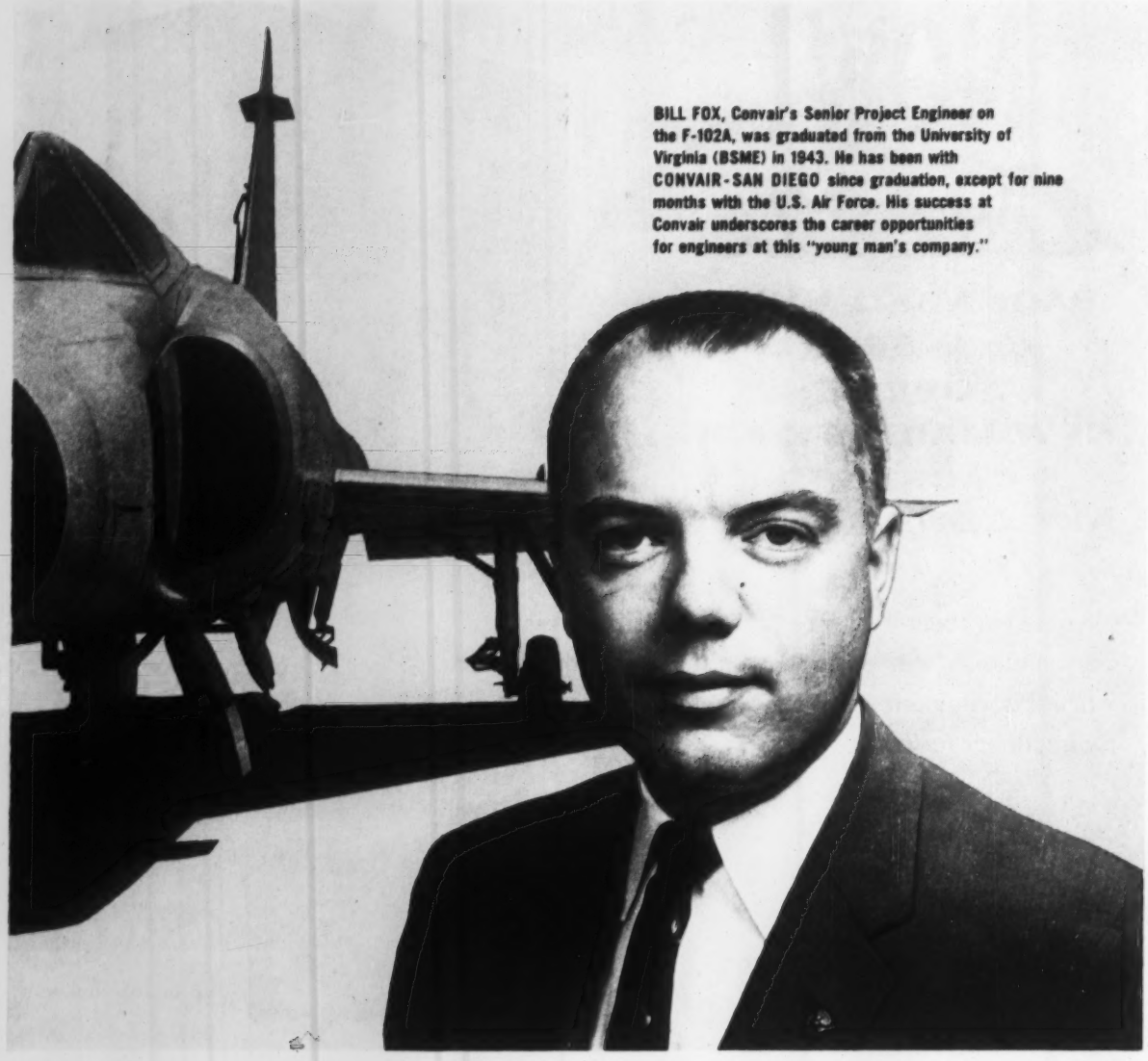
OUR 103rd YEAR

MANUFACTURING COMPANY
REFRIGERATION DIVISION
1940 Kienlen Ave. St. Louis 20, Mo.
CM-16

New Curtis Packaged, Air Cooled, Air Conditioning Units, 3 thru 7½ tons. Residential and commercial applications.

Condensing Units up to 100 tons. F-12 or F-22.

Air Handling Units, Cooling Towers and Evaporative Condensers to match.



BILL FOX, Convair's Senior Project Engineer on the F-102A, was graduated from the University of Virginia (BSME) in 1943. He has been with CONVAIR-SAN DIEGO since graduation, except for nine months with the U.S. Air Force. His success at Convair underscores the career opportunities for engineers at this "young man's company."

"Engineers—here's how the first application of 'Area Rule' made our Convair F-102A supersonic!"

"A prototype of the F-102, Convair's unique delta-wing interceptor, was being tested. While design changes were being evaluated, our aerodynamics group at CONVAIR-*SAN DIEGO* recommended the application of a new N.A.C.A. theory – 'Area Rule' – that would reduce the airplane's drag in the transonic range . . . push its speed beyond Mach 1.

"We put models through exhaustive wind tunnel tests. Mock-ups were built, checked and re-checked for construction details. A prototype based on the new 'aerodynamic recipe' was ordered. Then, in just 117 days, a new airplane – the Convair F-102A – was completed. Its wasp-waisted appearance reflected the *first application* of 'Area Rule' – made the F-102A supersonic.

"Important as this project was, it represents only *one* of the many creative assignments being solved at CONVAIR-*SAN DIEGO*—on projects like our F-102A Interceptor and Convair's 880—world's fastest Jetliner.

"You will like this *diversity* of activity, and the Convair atmosphere, where you see and feel accomplishment. You will enjoy living in beautiful, smog-free San Diego.

"For greater career opportunity, for stimulating diversity – *for your future's sake* – write for more information about CONVAIR-*SAN DIEGO* today!" Write Mr. H. T. Brooks, Engineering Personnel, Dept. 69H.

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SAN DIEGO

3302 Pacific Highway, San Diego, California

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analog computer
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A useful companion instrument is the new Sanborn Model 183 Programmer, designed to provide a connecting link between an analog computer and the Console Recording System. Shown mounted at the top rear of the Console, the Programmer operates the Console in the following automatic sequence: turns recorder drive on – feeds calibration signals to all channels – reads initial DC levels of computer – closes contacts to start computer problem – records computer output for a preset chart length – turns off recorder drive and resets itself for another cycle.

Further technical data, prices and delivery information — on the 5490/5495 Console Recording Systems and two- to eight-channel 5475/5480 Systems are available on request from your Sanborn Sales-Engineering Representative or the Industrial Division in Waltham.

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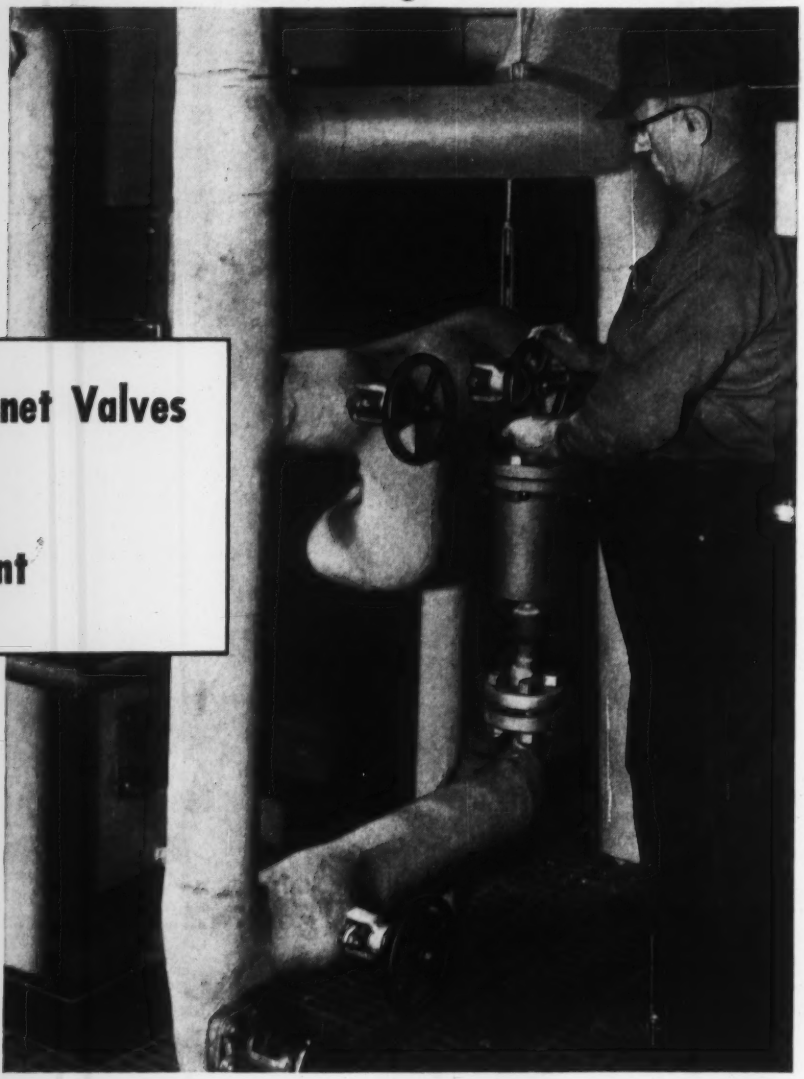
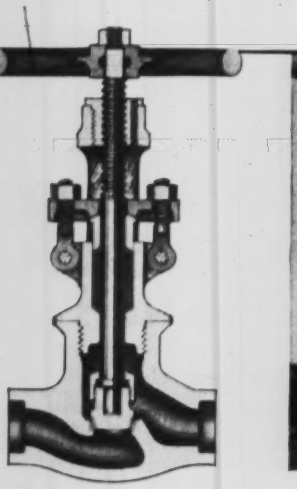


Crane Lip Seal Bonnet Valves
(patented)

Save Money for This Power Plant



Central Illinois Electric & Gas Co.'s experience with Lip-Seal valves is typical. Since 1952, this patented Crane small steel valve design for high-pressure/high-temperature service has saved this utility many dollars.

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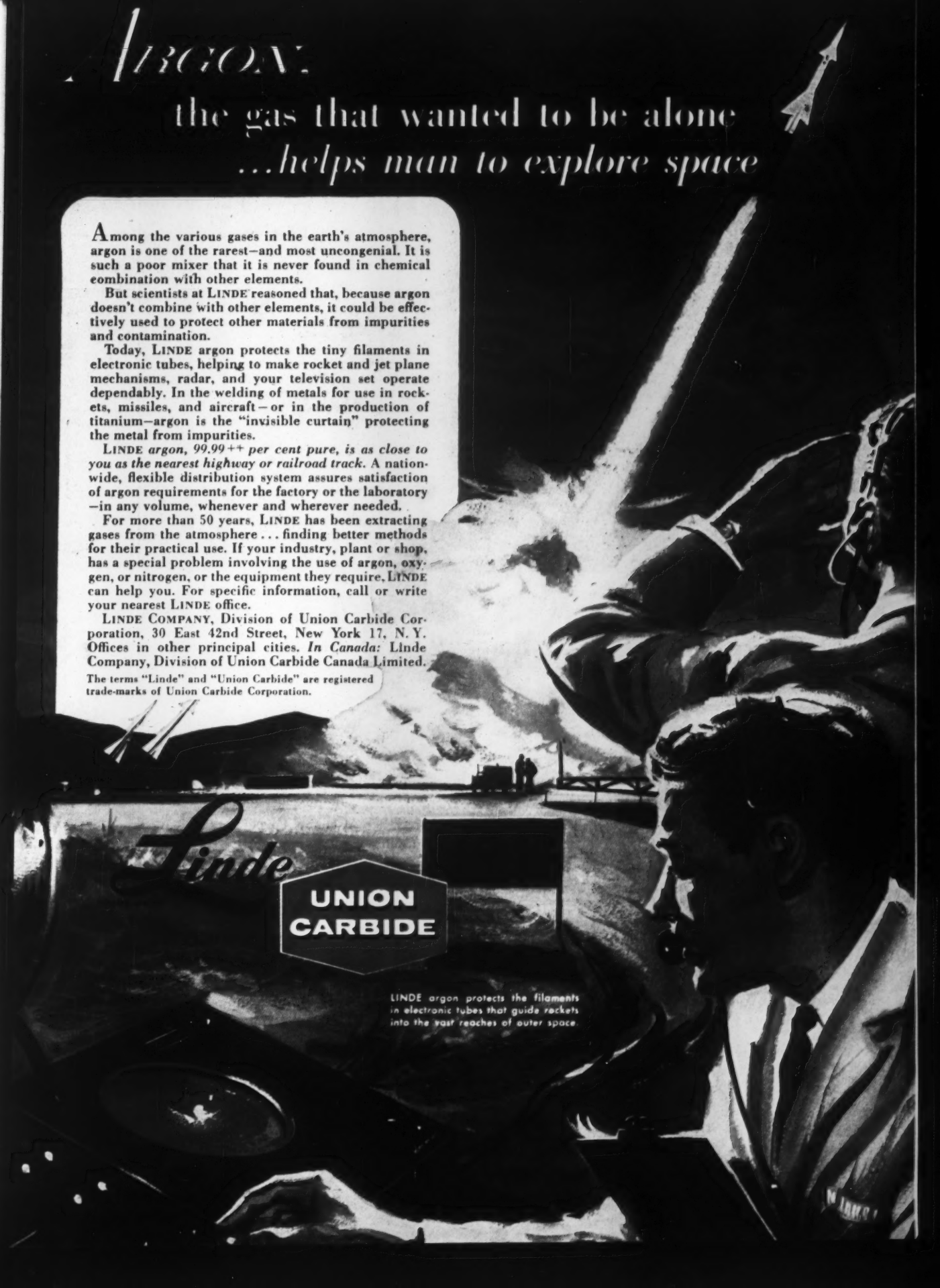

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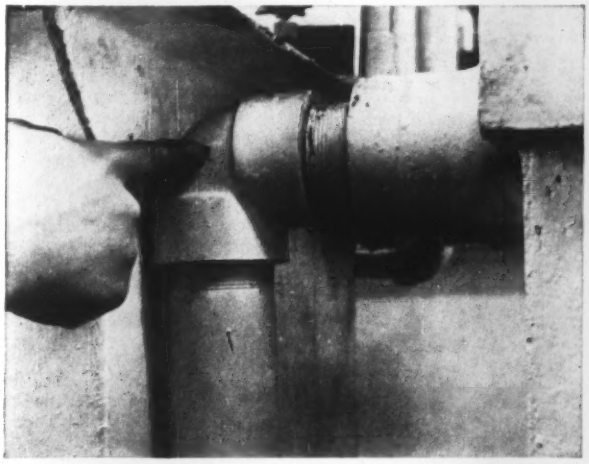

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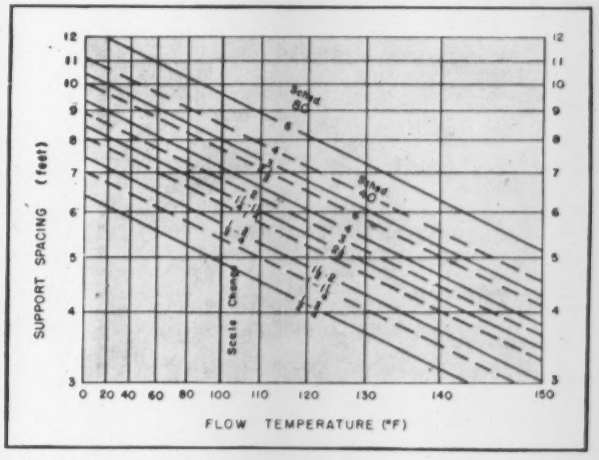
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3 4 5 6 7 8 9 10 11 12
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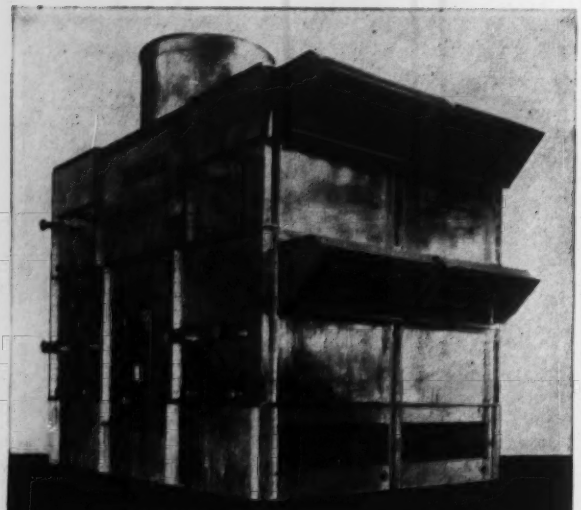

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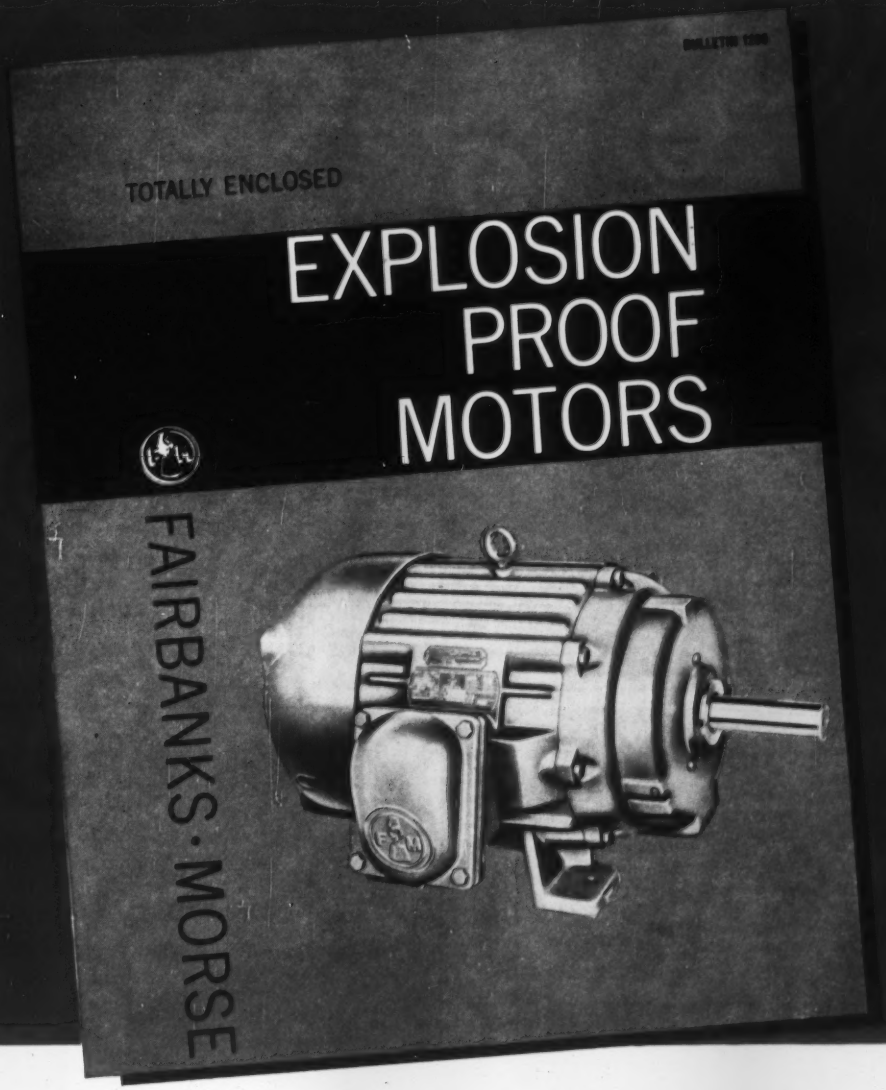

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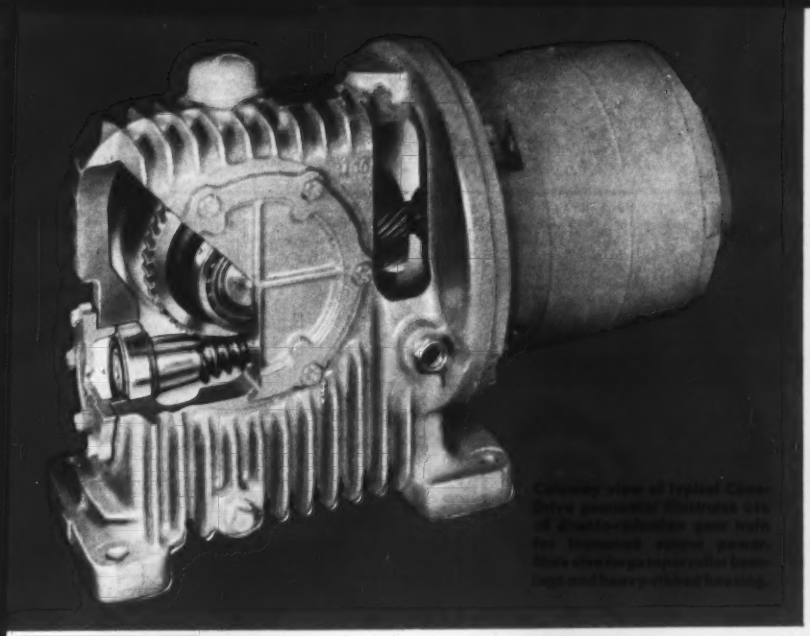

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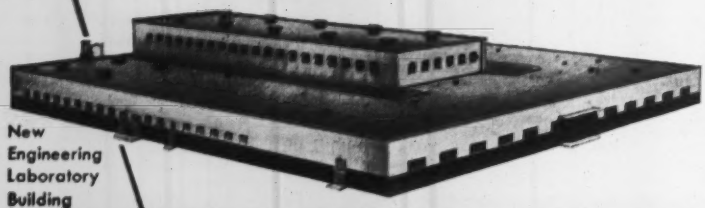

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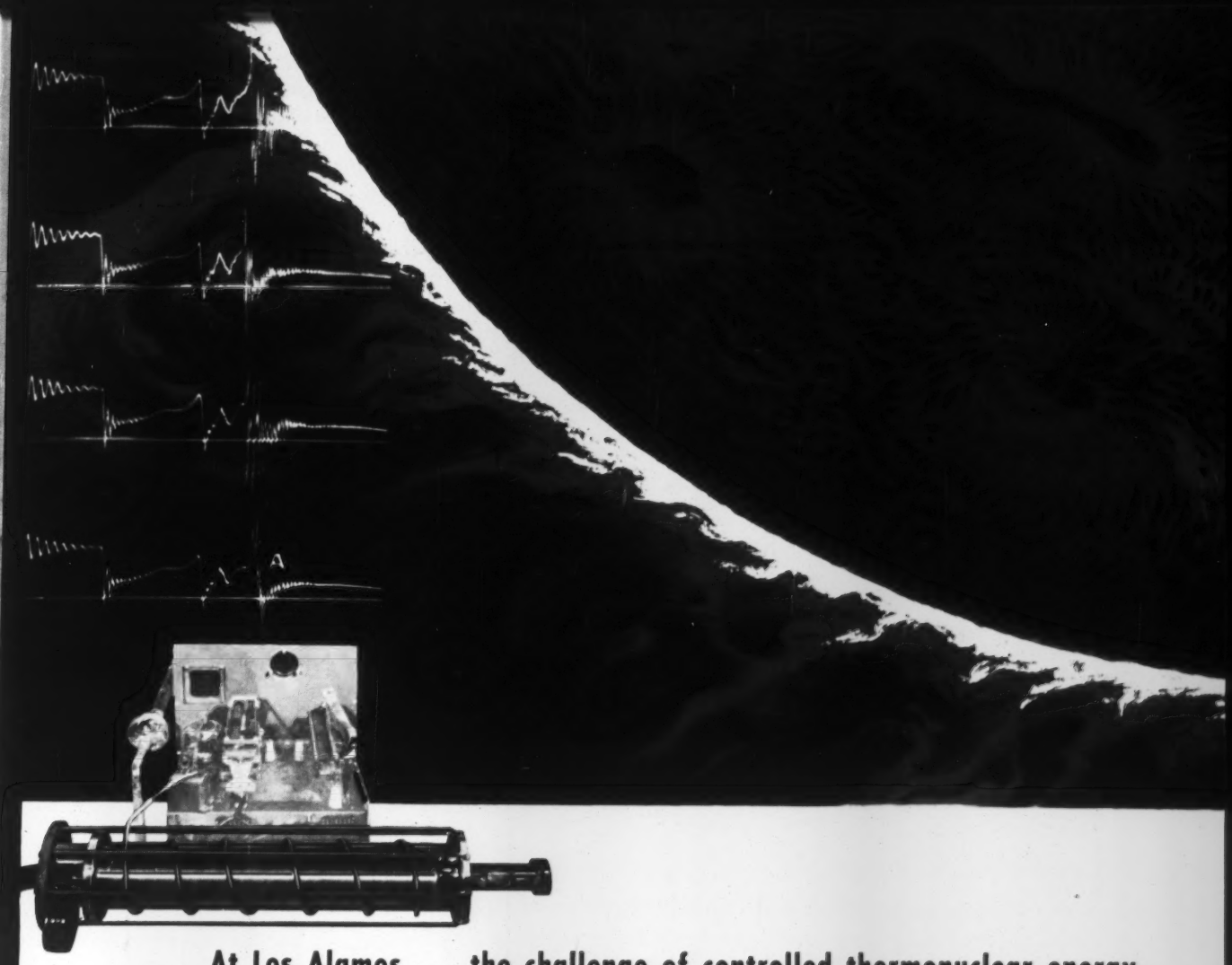

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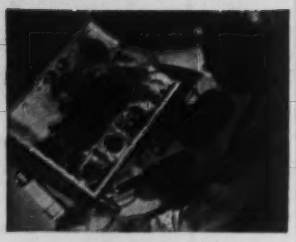

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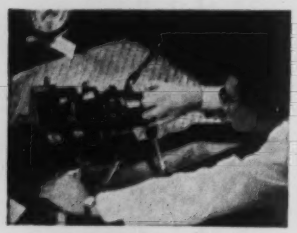

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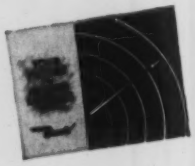

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Prominent multi-plant chemical manufacturer has 3 immediate openings for young sales engineers to participate in a vital sales development program to meet requirements of industrial hydraulic and lubricant applications. Candidates should have a degree in mechanical, automotive or petroleum engineering or equivalent with some experience in hydraulic systems engineering or lubrication. However, consideration will be given to allied sales engineering or service experience.
Positions require alert, aggressive sales-type individuals who will receive initial training in New York area and eventually be reassigned to the Great Lakes area. Good salary with liberal employee benefits. Write in complete confidence stating age, education, experience and salary requirements. Address CA-6292, care of "Mechanical Engineering."

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Expanding and diversified organization has permanent and interesting openings for top-level QC Engineers and Managers at several locations. Please submit complete details of education, experience, and earnings in confidence to:

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THE GENERAL TIRE & RUBBER COMPANY
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Continued growth and expansion creates an opening for a graduate engineer with at least 3 years' experience, preferably in wrapping, sealing and closing equipment in the flexible film and carton fields. This can lead to complete responsibility of packaging activities of our entire company.

This is an excellent opportunity for future responsibility in an expanding research and development department. Our Company has shown constant growth and development for 65 years' and offers opportunities with stability. Salary commensurate with qualifications. Complete benefit program.

If you are qualified and interested, write to R. C. Burrell, Technical Director, The Rath Packing Company, Waterloo, Iowa.

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This could be the break you've waited for. Not the "moon," but solid career advantages. If you're a well-grounded engineer blessed with creative imagination, you may be just the man our team is looking for. Write today to Mr. L. C. Bettega, Technical Personnel Recruitment, Chrysler Corporation, Engineering Division, P. O. Box 1118, Detroit 31, Mich.

"The Plainsman," one of many Chrysler Corporation experimental cars, offers evidence of the way the "Forward Look" continually looks ahead. To keep its well-earned position of industry leadership, Chrysler needs—and respects—the creative engineer.

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Project Engineer Robert J. Cantwell uses a system of gimbals to describe navigational problem in the analysis of a new system design.

Development Engineer J. Robert Holmes computes, with other systems reliability analysts, the operational worth of a bombing system.

Staff Engineer William Howard reviews gearing accuracy requirements of test equipment with electronic circuit designers.

You'll find a new challenge DEVELOPING airborne computers at

IBM Owego

Circuit Development Group Leader Ralph Wolcott considers future changes in computer output unit for bombing-navigational systems.

The design and development of BRANE (Bombing RAdar Navigation Equipment), now being installed in B-52 aircraft, offer stimulating new challenges to creative engineers at IBM Owego.

Projects currently in process include: Inertial guidance . . . display equipment . . . radar data presentation . . . digital and analog systems . . . transistor circuit packaging . . . test equipment . . . installation.

If you are an electrical or mechanical engineer, a mathematician or a physicist —and want to do development work— you owe it to yourself to investigate the exciting possibilities that airborne computers offer you at IBM Owego.

Development Engineer John Walsh discusses the use of a recording storage tube at IBM's Airborne Computer Laboratories, Owego, N. Y.

FOR DETAILS,
just write, outlining background and interests, to:
Mr. R. A. Whitehorne, Dept. 509
Mgr. of Engineering Recruitment
International Business Machines Corp.
590 Madison Ave., New York 22, N. Y.

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SO. NORWALK, CONN.

MECHANICAL ENGINEERS: Graduates BS and MS levels. For development of automation instruments . . . computer input and output mechanisms . . . memory devices. Includes paper and magnetic tape-handling equipment, punched card equipment, printer, magnetic storage drums, and machine design in mechanical and electro-mechanical fields. Send complete resumé to Mr. Robert Martin, Dept. NA-4, Wilson Ave., South Norwalk, Conn.

ST. PAUL, MINN.

MECHANICAL ENGINEERS: For development engineering work in computer input mechanisms consisting of cards, tapes and keyboard devices and high-speed output printing mechanisms. Will design cabinet structures, component packaging, cooling and ventilating systems and miniaturized components. Send complete resumé to Mr. R. K. Potterson, Dept. SA-4, Univac Park, St. Paul 16, Minn.

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HYDRAULICS TEST ENGINEERS
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Experience in programming engineering problems, such as aerodynamics, thermodynamics, structures, and dynamics for calculation on IBM 650 or 700 series machines. Background in numerical analysis techniques essential.

MR. JOE RUSSELL, Engineering Personnel
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You should have MSME or equivalent with 2 to 10 years' experience, some of which should be in instruction of technical students. Excellent benefits plus growth potential. Liberal relocation expense allowance.

Send complete resume including salary requirements to:

Director, Technical Education, Dept. M-2

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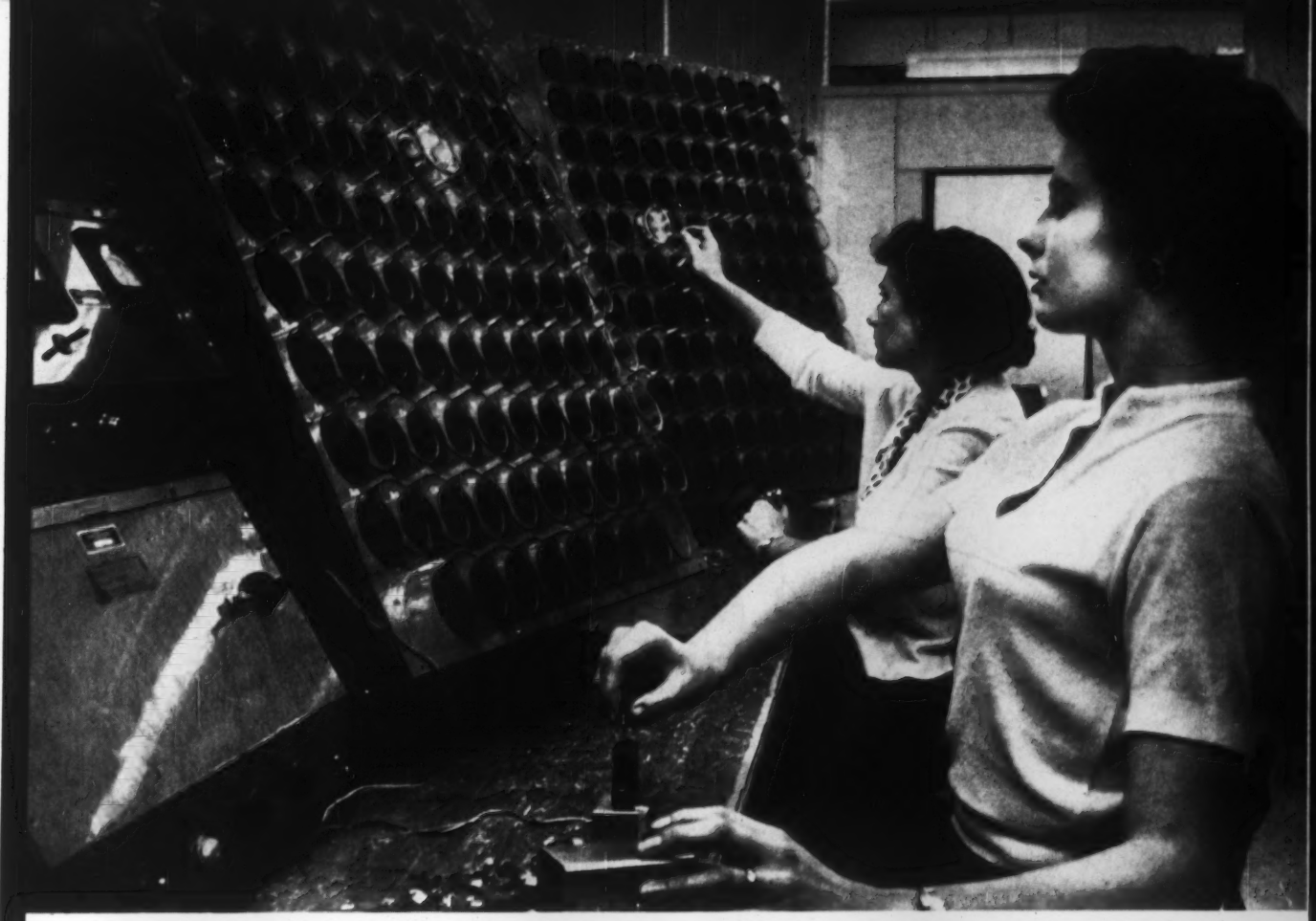

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Homely articles like water glasses and light bulbs are used in this automated selector built by TI mechanization engineers. Now, non-technical TI-ers close a circuit with a transistor just off the production line; wait a second for the circuit to evaluate it; then pop the unit into the glass that lights up. This "matching" operation is another advance toward automation of semiconductor manufacture . . . to free technical personnel for other important duties . . . to help Texas Instruments produce more electronic components and apparatus at lower cost.

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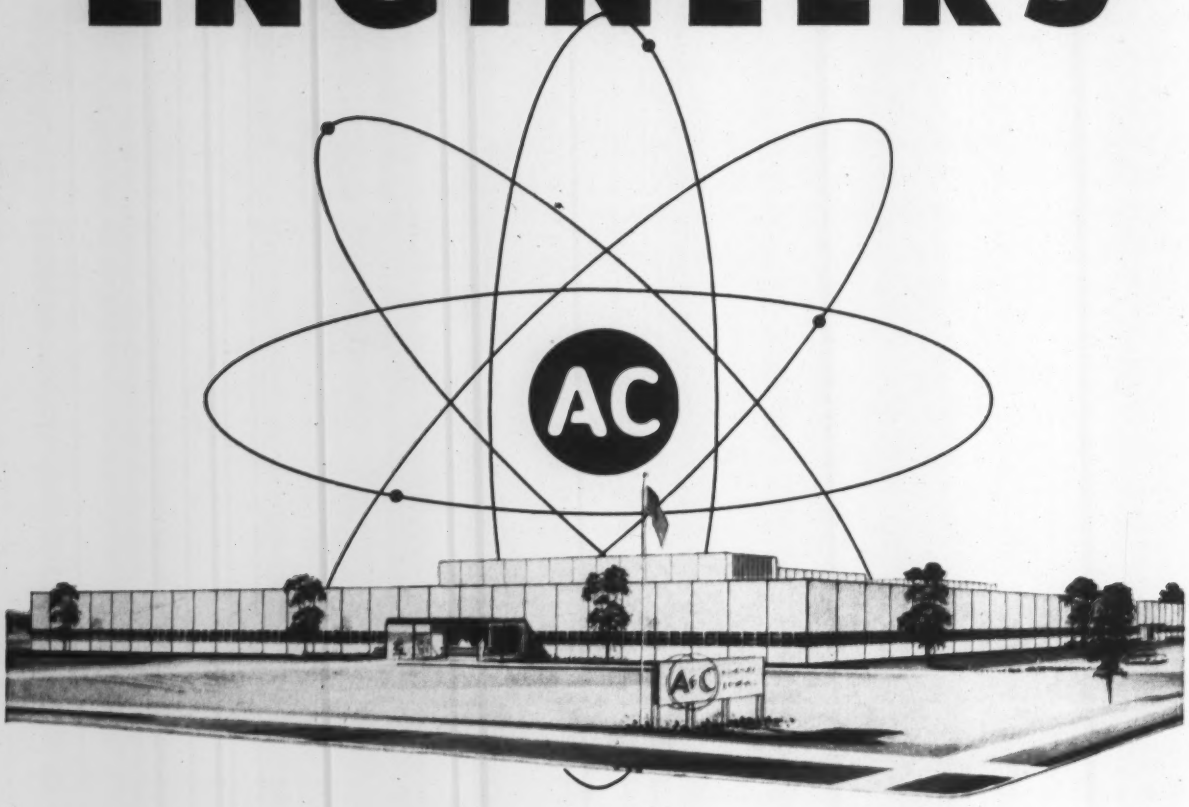

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"OPPORTUNITIES" Section This Month 163-176

Mechanical ENGINEER

To design and develop automatic equipment which will carry pilot line stage through full production. Involves design of automatic electrical testers, chemical process equipment, automatic assembly and feeder production problems.

Experience in the design of industrial automatic production equipment desirable.

Westinghouse ELECTRIC CORP.

Semiconductor Dept. Section EM
Youngwood, Penna. (30 mi. E. of Pittsburgh)

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Graduate mechanical engineer in power plant design work. Experience not required. Excellent opportunity with consulting engineering firm in the Middle West. Liberal benefit plans and good working conditions.

Send resume of education and experience with statement of salary requirements.

Address CA-5905, % "Mechanical Engineering."

SALES ENGINEER

Excellent opportunity with midwest manufacturer of mechanical power transmission components. Desire man experienced in sales engineering work with OEM and industrial distributor sales. Salary and expenses—Age 27–35 preferred but not necessarily a requirement. Send photo and complete resume.

Address CA-6247, % "Mechanical Engineering."

MECHANICAL ENGINEERS

PUMPING AND SOLIDS HANDLING

The engineering department of Monsanto's Research and Engineering Division offers two unusual opportunities to qualified engineers at the new Company Headquarters in St. Louis County, Missouri. In both instances, the engineers will serve as company-wide consultants in their respective fields and will develop new design procedures, methods and company-wide standardization programs.

Please mail full résumé to:

Director of Personnel
Research and Engineering Division
Monsanto Chemical Company
Box 8, Station B
Dayton 7, Ohio

PUMP SPECIALIST

BS/MS in Mechanical Engineering with 5 to 10 years experience preferably with pumping problems in the chemical processing industry. Design or technical sales experience may be alternates. Must be thoroughly familiar with selection, maintenance and performance of pumps particularly centrifugals. Knowledge of other types of pumps, compressors, and mechanical seals desirable.

SOLIDS HANDLING SPECIALIST

BS/MS in Mechanical Engineering with approximately 10 years experience in the solids handling field. Experience should include familiarity with pneumatic and mechanical conveyors, solids storage, packaging and warehousing. Industrial engineering training and classification experience are desirable. Sales or design background may be alternates for plant experience.

IMMEDIATE OPENINGS

MAINTENANCE ENGINEERS
PLANT EQUIPMENT INSPECTORS

Positions at all levels in new chemical maintenance engineering section of fast expanding, medium sized chemical producer.

Graduate Chemical, Metallurgical, Mechanical or Industrial Engineers with 2 to 10 years' experience in chemical plant or refinery experience, contact:

Stanley B. Lord, Supervisor
Maintenance Engineering
Pittsburgh Coke & Chemical Company
Neville Island
Pittsburgh 25, Pennsylvania
SPalding 1-4400

DESIGN ENGINEER

Continued growth and expansion creates an opening for a graduate engineer with at least 3 years' experience in design, preferably in food machinery.

This is in an excellent opportunity for future responsibility in an expanding research and development department. Our Company has shown constant growth and development for 65 years and offers opportunities with stability. Salary commensurate with qualifications. Complete benefit program.

If you are qualified and interested, write to R. C. Burrell, Technical Director, The Rath Packing Co., Waterloo, Iowa.

DESIGN ENGINEER
FOR PROCESS EQUIPMENT

Long established and growing New England manufacturer has opening for Mechanical Engineer to work on design of process equipment, involving heat transfer and static and dynamic thermal design. Must be familiar with TEMA and ASME codes. Desire man with creative ability who can work with a minimum of supervision. Send complete resume.

Address CA-6286, care of "Mechanical Engineering."

TEACHING POSITION available in mechanical engineering. Interest in materials, and machine design courses desirable but not essential. Assistant Professor rank. M.S. degree preferred. Apply: Executive Dean, Fresno State College, Fresno, California.

MECHANICAL ENGINEER—Preferably graduate M.E. with a few years' experience on machine design. We are Ceramic machinery manufacturers. Our business is nationwide. We have a factory and engineering office in a small town in upstate New York close to a Metropolitan and vacation area. The educational, recreational and cultural opportunities are excellent. You will get some administrative work but to start will be on development projects of varying nature. This is an opportunity to grow with a smaller concern. Contact Personnel Manager, A. J. Wahl, Inc., Boonton, N. Y.

ENGINEERS—Research and design, for newly organized research department. Must have experience in design of rotogravure printing presses, paper converting machinery or cutter creasers. Modern working conditions, excellent salary. Address CA-6295, care of "Mechanical Engineering."

Continued on Page 176

POSITIONS OPEN

Continued from Page 175

UNIVERSITY FACULTY POSITIONS: Professors wanted for two-year assignments at University of Indonesia in Java for service as follows: (1) Mechanical Engineer to teach Heat Transfer, Thermodynamics and I. C. Engines; (2) Professor of Higher Mathematics. Applicants should be over 30, advanced degrees preferred. Attractive salaries, travel expenses and housing furnished in a pleasant climate. Salary and rank dependent upon background. Send complete resume and small photograph to Merl Baker, Kentucky Research Foundation, Lexington, Kentucky.

ENGINEERS with mechanical and electrical background. Position at Minneapolis headquarters service department of progressive manufacturer of large synchronous and induction motors. Has unusual opportunity with responsibility for experienced man who prefers freedom in working with all departments regarding all lines of apparatus. Address CA-6250, care of "Mechanical Engineering."

SEE CHEMSTRAND'S AD ON PAGE 95 OF THIS MAGAZINE

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Moving expenses defrayed and excellent benefit program.

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Employment Supervisor
KAISER ALUMINUM & CHEMICAL CORP.
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POSITIONS WANTED

MECHANICAL ENGINEER—B.S. in M.E.—18 years' experience in refrigeration, air conditioning, ventilation and internal combustion engines. Experience includes heavy construction machinery, chemical and oil industries as engineer and consultant. Registered Professional Engineer in Michigan. Age 39, good health. Desire responsible position in industry or consulting fields. Address CA-6228, care of "Mechanical Engineering."

MECHANICAL ENGINEER seeks challenging opportunities in commercial nuclear power development. Age 33. BSME. Registered Professional. Member ASME. Married. Present position is project engineer and service supervisor in chemicals industry. Experience in design, development, procurement, construction and operation of production facilities and service systems. Address CA-6271, care of "Mechanical Engineering."

EXECUTIVE RESEARCH ENGINEER—M.E., Ph.D., P.E., age 37. Experienced in organizing and supervising R. and D. effort in precision product development, mechanics, and instrumentation. Seeks broader staff or supervisory responsibilities in progressive industry or research organization in Northeastern U. S. Salary requirements exceed $15,000. Not interested in missiles. Address CA-6281, care of "Mechanical Engineering."

CHIEF ENGINEER, large paper mfgr., wishes to relocate. 10 years' staff engineering large capital projects; consultation operating problems. Construction supervision. Hydro, steam power design, operation. M. S. degree, M.I.T. Presently employed. Address CA-6289, care of "Mechanical Engineering."

PLANT MANAGER—B.S. in M.E.—age 39—17 years' experience in electrical manufacturing, metalworking, machining and woodworking. Good record of accomplishment. Excellent references. Address CA-6298, care of "Mechanical Engineering."

PROFESSIONAL ENGINEER, Canadian, registered in Ontario. Twenty years' experience in the design production of small electromechanical devices. Ten years' experience in development and engineering research in large scale agricultural developments in Africa. Capable of managing small factory or will travel in any non-communist country. Available May 1958. Can be interviewed this fall in New York City. Address CA-6291, care of "Mechanical Engineering."

MECHANICAL ENGINEER—Member of ASME, Age 45; 17 years' experience in piping air conditioning, refrigeration. Desires to act as agent, representative, or liaison in Middle East, or Europe. Address CA-6307, care of "Mechanical Engineering."

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It will pay you to watch the announcements on these pages for an opportunity that you may be looking for or one that may be of interest to you.

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SALARIED POSITIONS—$6,000 to $35,000. We offer the original personal employment service (established 46 years). Procedure of high standards individualized to your personal requirements. Identity covered. Particulars—R. W. Bixby, Inc., 562 Brisbane Bldg., Buffalo 3, N. Y.

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Company client needs mechanical engineers with experience in heat exchangers, boilers, fluid hydraulics or related work will qualify you. Client is the leader in its field. You will enjoy suburban life in this vacation area. Company client assumes all expenses. Your present position held in complete confidence. Write to

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DISTRIBUTORS or REPRESENTATIVES—wanted for several open territories in Eastern and Midwestern states on our line of quality valves, cylinders, valve actuators and pumps. Write, giving lines handled and territory covered. Ledeen Mfg. Co., 3350 No. Gilman Road, El Monte, California.

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TRANSLATORS of all European and Far East languages, in all branches of engineering and physical sciences in general. Full time or free lance. Must be experienced specialists with fluency in English and given foreign language. Replies held confidential. Submit resume to: A.T.S., P.O. Box 271, East Orange, New Jersey.

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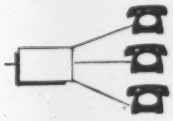
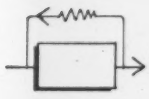
Pacemakers in the technology of our electronic age

Certain discoveries, inventions and developments of Bell Telephone Laboratories have been truly epochal in their effect upon the technology of our time. Each has come out of a single quest—a search for ways to make telephony ever better. But many have opened the way to exciting advances in TV, movies, radio, horology, astronomy. Here are ten of Bell Laboratories' contributions to the modern world.

Electronic amplifier. First high-vacuum electronic amplifier Made possible long distance telephony and then opened the way to radio broadcasting.

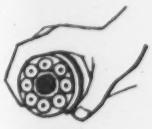


Wave filter. Precisely separates bands of frequencies. Provided major key to economical sharing of the same wires by many voices or radio programs. Indispensable control tool in radio, television and radar.



Negative feedback amplifier. Provides distortionless and stable amplification. Made possible the enormous, precisely controlled amplification needed in long distance telephone calls. The principle is now basic in high-quality amplifiers for radio, TV and high-fidelity reproduction.

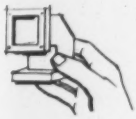
Quartz crystal. Standard super-accurate quartz crystal oscillator developed for frequency controls in radio telephony. Has also become the standard control for clocks in world's astronomical laboratories.



Coaxial cable system. Hollow tube with a central conductor was developed to transmit hundreds of voices simultaneously. Now also provides long distance carrier for TV in partnership with microwave beams.

Transistor. Tiny solid-state device uses extremely small amounts of power to amplify signals. Makes possible electronic telephone switching and much smaller hearing aids, radios, TV sets and electronic computers.

Dial system "brain and memory." Takes over your call and sees that you are connected in the best and quickest way. Newest example: Direct Distance Dialing from home telephones to any part of the nation.



Waveguide. Hollow conductor transmits high-frequency waves. From this came the "pipe" circuits that are essential to radar and very short-wave radio communications.

Microwaves. Bell Laboratories developed long distance microwave transmission. It operates by focusing radio beams from station to station, carries cross-country telephony and TV.

Radio astronomy. This great new science began in the study of radio interference at Bell Laboratories . . . with the tremendous discovery that radio waves emanate from the stars.

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WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

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MICRO-BEARING ABSTRACTS

by **A. N. DANIELS**, *President*
New Hampshire Ball Bearings, Inc.

CONTACT ANGLE

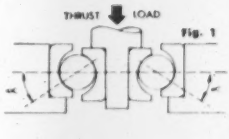

Fig. 1

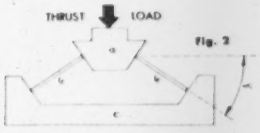

Fig. 2

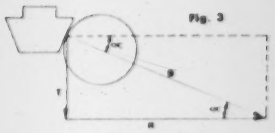
Fig. 3

Contact angle is the angle between a plane perpendicular to the bearing axis and a line connecting the two points on a given ball where the ball makes contact with the raceways when the bearing is subjected to a pure thrust load. In *Fig. 1*, the contact angle is represented by angle α. The significance of the contact angle is revealed by an examination of the forces present in a thrust loaded bearing.

In *Fig. 2*, a simplified version of *Fig. 1*, the shaft and inner ring combination are represented by the plug a, the "working diameters" of the balls and represented by the rodlike members at b, and the outer ring is represented by the tapered cup c.

The contact angle is α. This diagram represents a three-dimensional structure with as many equally spaced rods, b, as there are balls in the bearing.

The primary concern in design is the amount of compressive force to which rod b is subject, which is the force with which a given ball is pressed against the raceways. This force can be calculated by constructing a parallelogram of forces as shown in *Fig. 3*.

The sides T and R, are vector quantities, and diagonal B is the vector sum of T and R. Furthermore, the vector sum of the thrust components on all the balls equals the total thrust load on the bearing. The vector sum of the radial components on all the balls is zero. Vector B, the force actually felt by the raceways and balls, compared to vector T, the thrust component, varies significantly with changes in the size of the contact angle and is directly proportional to the thrust load component and inversely proportional to the sine of the contact angle.

Example I:

A bearing is carrying a pure thrust load of 21 pounds. Assuming seven balls in the bearing, each ball will have an axial load component of three pounds, since a thrust load is shared equally by all the balls. While the axial component on each ball is only three pounds, the actual compressive force, or squeeze, felt by the ball and raceways is considerably greater than this value.

With a contact angle of five degrees:

$$B = \frac{T}{\sin \alpha} = \frac{3 \text{ lbs.}}{\sin 5^\circ} = 34.5 \text{ lbs.}$$

Thus we see that with a five-degree contact angle the actual load felt by each individual ball is actually considerably greater than the total 21 pound thrust load on the bearing.

Example II:

Using the thrust conditions in Example 1, the contact angle is increased to 20 degrees, by selecting a bearing with a larger value of radial play.

$$B = \frac{3 \text{ pounds}}{\sin 20^\circ} = 8.78 \text{ pounds}$$

A 15 degree increase in contact angle produced a 74.5% reduction in ball-to-raceway contact stress. This relationship should be noted by anyone who writes bearing specifications. The operational qualities of the bearing, such as low running and starting torque and bearing life, are a function of the ball-to-raceway contact stress. Thus the contact angle is highly significant.

It is not necessary for a bearing user to calculate or specify the contact angle desired. It is only necessary to remember that low values of contact angle are associated with low radial play, and high values of contact angle are associated with high radial play. In addition to the above considerations, gyratory forces become extremely important factors in determining optimum contact angle in high speed applications.

A more complete discussion of contact angle is found in our design handbook.

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ONE ANSWER
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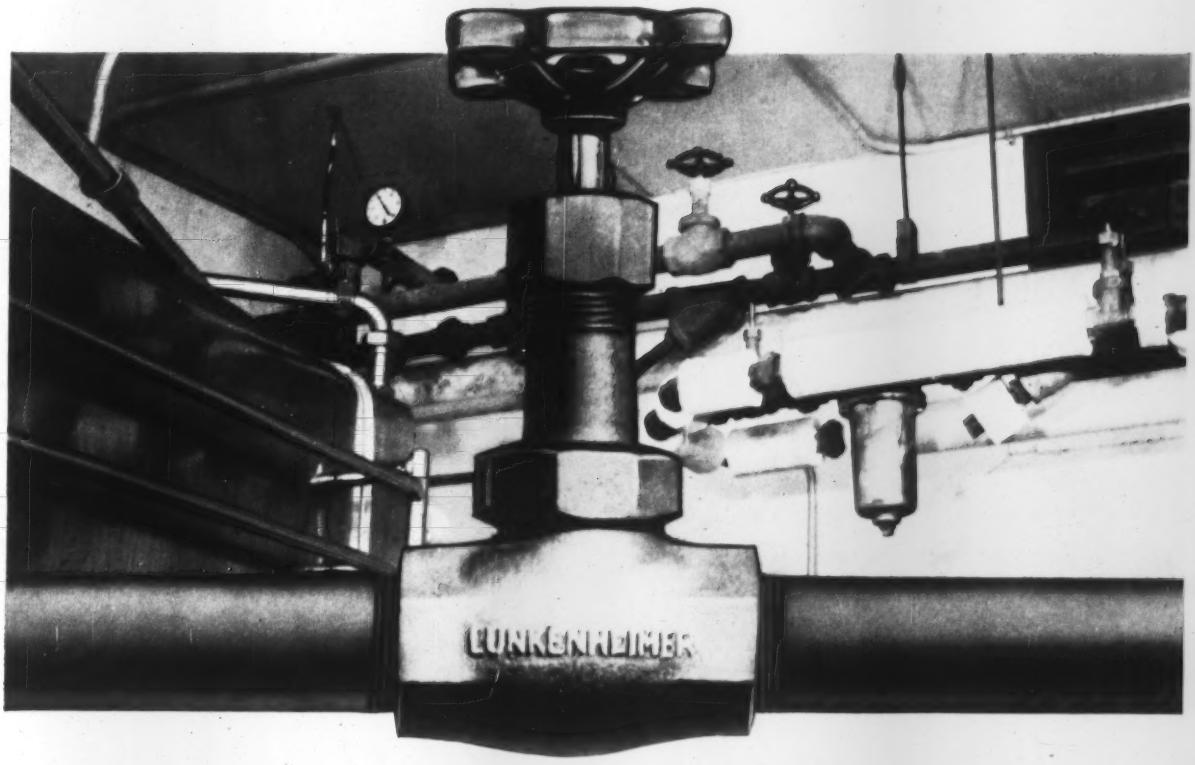

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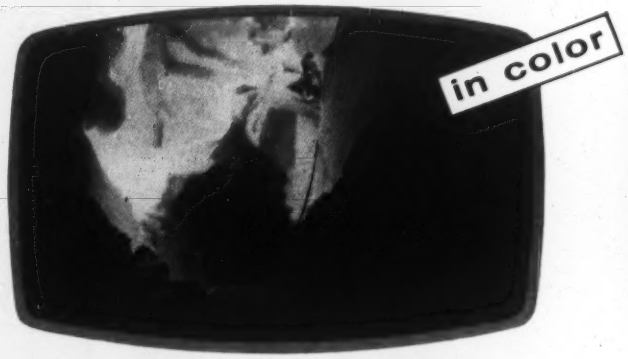

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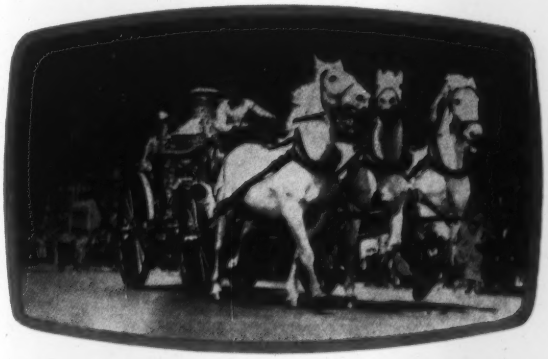

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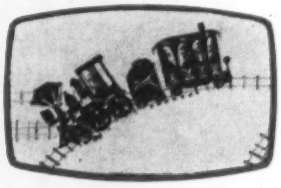

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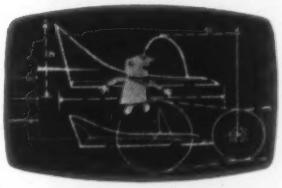

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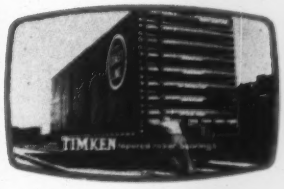

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